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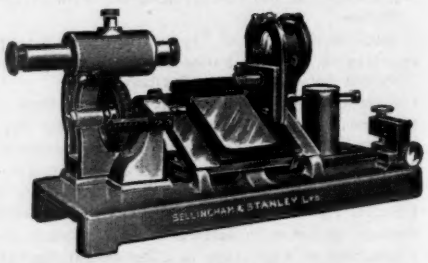

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SCIENTIFIC BOOKS AND PAPERS

THE paper entitled "The Tower of Babel: the Language Barrier in Science" which Mr. B. C. Vickery presented before the Library Association at its annual conference at Southport on September 22 deals with some aspects of the communication of knowledge and ideas with which the scientist is particularly concerned. Mr. Vickery discussed more particularly the difficulties which language differences create in communication between scientists; and his observations on the question of translations, made from the point of view of one who is librarian in the Akers Research Laboratories of Imperial Chemical Industries, Ltd., deserve the attention of the research worker and technologist quite as much as that of the librarian. Moreover, some comments on the multiplicity of scientific and technical periodicals have disturbing implications for the scientist and technologist as well as for the librarian.

Mr. Vickery approaches the whole subject with the firm purpose of attempting to remedy the inadequacies of modern methods of communication by the printed word, and not the least merit of an admirable survey is that he sets his problem in the context of a lucid historical survey, which incidentally disposes of any claim for French as the major medium of communication at any time in the scientific world. He starts, however, by referring to a protest made by Dr. Ancel Keys some five years ago in *Science* on the appearance of a periodical, the *Acta Physiologica Polonica*, written entirely in Polish. This represented a break with the pre-war practice of the Central European countries of providing summaries in German, French or English when the text of the papers appeared in a minor language. The protest pointed out that in modern times the overwhelming majority of scientific work is published in English, French and German, with an increasing proportion in Russian, and to a lesser extent in Italian and Spanish. This protest brought a reply that to require minority linguistic groups to publish in languages other than their own would be to handicap whole nations of scientists, and it was argued that the real difficulty was that all countries are publishing in so many varied languages. Dr. J. E. Holmstrom has estimated that about fifty per cent of the world's scientific papers are written in English, about fifteen per cent each in French and in German, perhaps ten per cent in Russian, while the remaining ten per cent are published in other languages, including two to three per cent in Spanish. That estimate alone sufficiently illustrates the unrealistic character of the reply to Dr. Keys's protest, nor is that comment substantially affected if Mr. Vickery is correct in his assumption that the situation is likely to get worse. The proportion of scientific periodicals published in Russian has probably doubled in the past twenty years, and it may well be true that the importance of Russian and Japanese and possibly Spanish will continue to increase and that of French and German to decrease. It does not, however, seem reasonable to anticipate, on the most chauvinistic forecast, that the contributions of each linguistic group will in the foreseeable future be proportionate to its size. Chinese may come to assume major importance; but there is little evidence as yet of any vernacular language emerging in India or Pakistan capable of overcoming the practical difficulties involved in replacing English as a *lingua franca* of scientific communication.

Such a forecast, indeed, implies a political climate most unfavourable to continued scientific advance, and happily in sharp contrast with that manifested at the recent international conference at Geneva on the peaceful uses of nuclear energy. There was little support for such pessimism in the atmosphere of that conference, and such forecasts entirely overlook two important restraining factors, one primarily psychological and the other financial. If nationalism prevails to the extent implied in Mr. Vickery's prediction, we are more likely to re-enter the dark ages than to approach one of free communication of ideas and unrestricted scientific and technical advance.

The psychological factor is indicated in the valid comment, made in replying to Dr. Keys's protest, that it is much more difficult to write a paper accurately in a foreign language than it is to translate a paper from a foreign language. That is true; but it equally follows that a paper is likely to be more accurate if the writing into a foreign language is done by the author himself or in association with the translator, than when done by some translator not in direct touch with the author. If our primary concern is for accuracy, we can scarcely escape association of the author with the task of translation.

The real factor, however, as is well realized, for example in the Scandinavian countries, is that a nation using what may be termed from a world point of view a minority language cannot escape bilingualism if it desires to attain high standards of culture and scholarship. It cannot afford to cut itself off from direct access to the world's literature or from discussion with professional men in other countries of new advances in science, in technology, in art and sociology, which limiting itself to its own language would involve. The choice of which major language to use may be difficult, and Mr. Vickery may be quite right in predicting that the Asian peoples may adopt Chinese and possibly some other indigenous language as a *lingua franca* throughout that area. But that the scientist in Java, in India, in Japan, in Nigeria or elsewhere can keep himself abreast of scientific advance in the world by relying solely on a knowledge of his own vernacular, and that he will not acquire a working knowledge of at least one major scientific language, is inconceivable. It ignores, in fact, the scientist's own desire to publish his work where it will be known and read by his scientific colleagues whatever their race.

The financial factor is likely to restrain excessive nationalism still more effectively. Even in Great Britain, major scientific societies such as the Chemical

Society with a membership of several thousand find great difficulty in meeting the mounting costs of publication. Nationalism could indeed induce Governments to bear a large proportion of the costs of publication if national prestige is involved. But in countries where the demands on Government are likely to be greatest if publication of new scientific and technical periodicals in a minority language is to be possible, economic resources are already stretched and limited, and there are likely to be strict limits to the support which the Governments can give to ventures that promise no solid return and only pander to national vanity.

Nor can the prospective publisher of such new scientific and technical periodicals count on a wide overseas demand. Few scientific and technical libraries are even now able to subscribe to all the scientific and technical periodicals they wish, or to buy the number of copies of individual periodicals that efficient service would suggest. The figures for expenditure on periodicals by the university libraries of Great Britain, which are given in the annual returns from universities and colleges issued by the University Grants Committee, show not only how limited are the funds expended for that purpose, but also how far over the past decade or more such expenditure has failed to keep pace with the mounting costs of scientific and technical periodicals. Figures given for a few of the larger technical college libraries by Mr. C. H. Wright in a paper in *The Engineer* last May show that even such major institutions as the Manchester College of Technology, the Royal Technical College, Glasgow, the Northern Polytechnic and the College of Technology and Art, Leicester, have to be severely selective in their range of periodicals.

It is unrealistic to assume that to-day a new scientific or technical periodical can count on more than a limited volume of support, unless in most exceptional circumstances. From the purely scientific or technical point of view, everything points to the desirability of counteracting the unavoidable tendency to specialization by concentrating publication in a relatively few major periodicals in languages which are widely understood and read. From that point of view it could, of course, be urged that use of some one universal language would have an overriding advantage without tending to encourage chauvinism. Apart, however, from the practical difficulties in selecting such a language, Mr. Vickery's historical survey suggests that for the present, in any event, such a proposal is unrealistic and premature, even if we discount somewhat the development of vernacular literature in Eastern Europe, Asia and Africa.

Mr. Vickery concludes from his survey that science has been faced twice before with a great language problem, and that each time the barrier to scientific communication fell to an organized attack on it by men of great zeal and scholarship, patronized and financed by the highest authorities in the land. It is not necessary to adopt that conclusion without reserve in agreeing with him that the pressing and more complex problems of scientific and technical publication in Britain can only be solved by a similarly grand plan of attack. Mr. Vickery does not outline such a plan, but he makes several sound suggestions as to what is needed, and these suggestions call for study and support by professional bodies and learned societies as much as by librarians.

The first need, Mr. Vickery suggests, is for effective bibliography—a list of all books and papers published. Although, as he rightly remarks, this primary need is at present only imperfectly met and there is much overlapping, it should be noted that the science centres of Unesco are attempting to deal with the problem and have done something to meet the needs of the Middle East, Asia and the South American countries. The second need, he suggests, is full translations, or at least précis, of the more important papers. This need Mr. Vickery discusses in more detail, without, however, indicating the extent to which use is made of English in this respect. He rightly emphasizes, however, that attention should be concentrated on the major scientific periodicals, and to do so would probably encourage the inherent tendency of the scientist to publish in the most widely read and used periodicals.

On the third need, for more facilities for getting translations of any particularly useful paper, Mr. Vickery brings out the inherent difficulties as regards speed, accuracy and cost, emphasizing the need for more good technical multi-lingual dictionaries and for scientists with a good knowledge of two or more languages. He indicates something of the possibilities of mechanical translation but emphasizes the need for further organization and co-operation in this field, including the formation of scientific translation bureaux. He does not claim that his suggestions are novel but merely that they continue current trends.

What is needed, Mr. Vickery argues, is the concerted planned attack on the whole problem of scientific communication already mentioned. The prelude to such collaboration of scientists, translators and teachers as he suggests would seem to be a preliminary study of the various aspects of the problem by professional bodies and learned societies of the scientific world, as well as by librarians and information officers. A weakness of Mr. Vickery's survey is, in fact, the omission of any reference to what has already been done in this field by the Abstracting Board of the International Council of Scientific Unions. Co-operative efforts in physics have now extended to chemistry and promise to cover biology and mechanics also, while the feasibility of a comprehensive Russian to English translating service has been explored and an initial effort started by the American Institute of Physics. A lead is clearly required by the scientist, however, and that lead should not only emphasize the vital importance of free communication of knowledge and ideas, but also the incompatibility of scientific advance with the nationalism which in the past forty years has done more than anything else to hinder communication and obstruct scientific advance. On that issue neither the self-respect of the scientist nor the prudent use of resources permits compromise.

THE UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION

The Story of FAO

By Gove Hambidge. Pp. xii+303+30 plates. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 48*s*. net.

OF all the activities of the United Nations, none seems likely to have more lasting effects than its Food and Agriculture Organization, often known as FAO for short, and not to be confused with FOA, the Foreign Operations Administration of the United States, which sometimes operates alongside though always in harmony and with no overlapping. The Food and Agriculture Organization was founded in Quebec in October 1945 with the purpose of carrying on the "War against Want" which was one of the declared purposes of the historic Atlantic Charter, and the tenth anniversary was but recently celebrated on October 15 last in the Organization's birthplace. The British people can justly feel proud of the leading part played in its foundation by Stanley M. Bruce, now Viscount Bruce of Melbourne; F. L. McDougall, also of Australia; and John Boyd Orr, now Lord Boyd Orr. Bruce's famous speech at the League of Nations meeting in 1935 directed attention to the anomalous situation that had then arisen: agriculture in the advanced countries was seriously depressed because farmers could not sell the food they were producing, and they were advised to produce less, while in the less-advanced countries millions of people went hungry and suffered accordingly in health and efficiency. He urged the imperative necessity of effecting a "marriage of health and agriculture". The idea gradually developed. A few years later (1942) McDougall proposed the establishment of a Food and Agriculture Organization of the United Nations to study problems of nutrition and food supplies in the different countries and to foster greater output wherever necessary; by 1945 the Organization was established with John Boyd Orr as head. An account of its achievements is now given by the well-known American agricultural writer, Gove Hambidge, in the present book.

No fewer than seventy-one countries contribute to the Organization; but the largest part of the cost—30 per cent—is borne by the United States, and the second largest—10·5 per cent—by Great Britain, this being the relative numbers of the population, though in relation to the national income per head the British contribution is double that of the United States. The budget for the ordinary programme of work is 6 million dollars annually.

Its best-known work is the *Survey of the World Food Supplies*, produced periodically, which shows how much food each country is producing and expresses the results as calories supplied per head per day; these are compared with the numbers considered desirable. These statistics are the best available; unfortunately, the U.S.S.R. and its satellites do not participate, so that they have to be excluded from the tables, and we have little trustworthy information about their food resources.

More important than the statistical records is the technical aid offered to the countries where the food supplies are obviously inadequate. This began in a small way at the Geneva Conference in 1947 and was greatly extended after the 1950 Technical Assistance Conference of the United Nations when fifty governments subscribed some 20 million dollars for technical aid. The United States contributed 60 per cent of this sum, 29 per cent being for the Food and Agriculture Organization and the rest going to the World Health Organization, Unesco and other bodies. The story of the resulting achievements occupies a large part of the book.

The first important operation was in China, where a campaign was started against rinderpest, estimated at that time to be killing a million animals a year there. Fortunately, a vaccine had been discovered during the Second World War, the search having been stimulated by the fear that the Germans or the Japanese might liberate the virus in North America and so wipe out the cattle population. Suitable methods of use in China were worked out. Chinese technicians were trained, and the programme included the vaccination of some fifteen million cattle. Other important agricultural improvements were also undertaken and large sums of money had already been spent when for political reasons the teams had to leave China late in 1948. Similarly, much good work was started in Poland and Czechoslovakia; but these countries also withdrew from membership, leaving the work uncompleted.

Elsewhere, however, very valuable results have accrued: animal diseases have been better controlled, and higher output of food crops achieved. Tests have been made in a number of countries of hybrid maize, one of the United States' great gifts to the world: it is proving very valuable in the Central and Eastern Mediterranean countries, giving up to 50 per cent higher yield than the older sorts, and it now forms some 30 per cent of the Italian crop. In Siam, fish culture in ponds is being extended to make good some of the shortage of protein in the people's diet; in the Arabian peninsula joint action against locusts has been organized; much work is being done on rice; and R. O. Whyte and his team have promoted surveys of the grasslands of India and other countries.

No less than fifty-three countries are being helped by the Food and Agriculture Organization, and some three hundred experts are engaged in the field. Steps are taken to train local people to continue the work after the Organization's teams leave. It is a great enterprise never before attempted in the history of the world, and the sincerest wishes for its success must go out to the director-general, P. V. Cardon; the director of the very important Agricultural Division, F. T. Wahlen; and all the staff.

E. JOHN RUSSELL

SURVEY OF CANCER

One in Six

An Outline of the Cancer Problem. By Dr. I. Hieger. Pp. 80+15 plates. (London: Allan Wingate (Publishers), Ltd., 1955.) 12*s*. 6*d*. net.

IT is almost as difficult to review a popular book on cancer as to write one, and for similar reasons. The subject ranges over such a vast canvas that one is always acutely aware of numerous important omissions and of the minor distortions which inevitably appear. No one can assimilate all the facts, and a selection tends to be confusing without the aid of an accepted unifying concept of the nature of cancer. In writing a short popular account, one is compelled

to stress those aspects most dominant in one's own experience, and Dr. I. Hieger naturally stresses the important role of the chemical carcinogens in etiology. He was in the team which first isolated from coal tar a pure chemical carcinogen, and he gives us the most interesting story of this pioneer discovery. Moreover, we have seen lately the firm linkage of exposure to tobacco and industrial smoke to the tremendously rising incidence of lung cancer. Up to now, the types of human cancer with a definitely proved relation to exposure to chemical carcinogens, though important, were a small part of the human total. If it is shown that lung cancer is in fact due to exposure to chemical carcinogens in smoke, their practical significance in human cancer will become of greatly enhanced importance.

It is possible that these statistical findings have stimulated the author to write this book and to devote one out of the five chapters to lung cancer. Even here, however, while the firm evidence for its relationship to cigarette-smoking is clearly presented, the assumption that this is due to the carcinogens undoubtedly present in the smoke, even if in very small concentration, cannot yet be justified. Of course, even if this assumption is not true, it will not affect in the slightest the practical danger of heavy cigarette-smoking. But knowledge of the real mechanism could very well affect profoundly our mode of approach to the millions of cigarette smokers, a substantial proportion of whom may, on the basis of a simple carcinogen hypothesis, be doomed to die of cancer of the lung. This illustrates one of the difficulties inherent in the popular approach to an enormously complicated subject which also has profound applications to the welfare of man—so profound indeed that the average man manages to forget about it completely and, short of man-handling, cannot be induced to listen to a popular lecture on the subject.

It is difficult to know how far any popular book on cancer can give anything but a confused idea of the present trends in research. It can, of course, state what some of them are and indicate some of the major advances of the past. Long experience of teaching medical students reveals that the great majority of them retain only the haziest notion of even the most elementary facts about cancer research, despite having received systematic instruction. This suggests only a faint possibility that the ordinary layman will derive any clear picture from popular accounts at the present time. On the other hand, the scientist would find much of the present book too elementary in his own field, and would get an incomplete idea of the scientific basis of the problem in other fields. This is not a criticism of this book in particular, which is a fairly good specimen of its kind. It is quickly read and gives quite a lot of interesting statistical information about cancer mortality-rates. Here, incidentally, the author brings out the point that the overall cancer death-rate, adjusted for age grouping, has not significantly altered during the past forty-five years. He does not comment on the disturbing fact that while diagnostic methods have continually improved and treatment facilities widely expanded, the mortality from cancer remains practically the same. The cancer problem is full of such paradoxical facts; and since all are subjects of debate and argument, it would be unfair to expect any writer to enter into these controversial issues in a popular account. The reader who would like to know something about a few of the many thousands of facts which cancer research has elucidated should turn to Dr. Hieger's book, for it is some time since we had a popular book from an established scientist in the field. The book, therefore, has the merit of being reasonably up to date.

H. N. Green

THE TEACHING OF MODERN PHYSICS

Introduction to Experimental Physics

By Prof. William B. Fretter. (Prentice-Hall Physics Series.) Pp. viii+349. (London and Glasgow: Blackie and Son, Ltd., 1955.) 35*s*. net.

THIS book consists of notes, taken at the time and written up by Dr. W. B. Fretter, of lectures given by fifty-two lecturers in the University of California, Berkeley. The chapters deal with a wide variety of subjects, from low-temperature work and spectroscopy to pile techniques and cosmic rays, all within 344 pages. It is not surprising, therefore, that the information provided is exceedingly scrappy. There is no consistent thread running through the book, and sometimes scarcely one going through a single chapter.

Unfortunately also, the separate scraps are themselves often incoherent. For example, ten pages are allotted to the subject of cyclotrons, including an account of the principles of the ordinary cyclotron and the synchro-cyclotron. There is no picture of what a cyclotron looks like, and no intelligible description of the ion source or of the radio-frequency system. Also, although phase stability is briefly discussed, there is no general description of particle oscillations. Instead, the chapter looks like a set of notes by a student who, already knowing a good deal of the subject, jots down the points that interest him. These include very brief remarks of various engineering items, mostly associated with the Berkeley 184-in. cyclotron. This kind of treatment is quite typical, and in fact some other topics are even more sketchily dealt with.

Although a student already well versed in the various subjects will certainly find many considerations and ideas which he may not have thought about, for a raw student the book would be useless.

This is not the way to teach physics. A book or a set of lectures should have as its main aim coherence. This can be done at any level, elementary or advanced. If the book is to be advanced, since it should include a complete account of the subject, it will need to be of appropriate length. It is not possible to treat thirty-two separate, mostly independent, topics at a rather advanced level with on the average only eleven pages for each. If one takes at random any of the topics dealt with, say magnet design, this should either be dealt with from an elementary point of view in a book about electromagnetism, or, if one wants to go into detailed practical applications, a special book would be required. A few pages of miscellaneous information serve no purpose.

In any event, I think it is a mistake to try to teach elementary techniques in isolation. It is much better to give a treatment dealing with all the aspects of the subject. For example, cyclotrons are best treated in connexion with the subject of nuclear disintegrations. This is the usual method, and I am sure it is right.

H. W. B. Skinner

A NEW MONOGRAPH ON DDT

DDT

Das Insektizid Dichlordiphenyltrichloräthan und Seine Bedeutung. Herausgegeben von Paul Müller. Vol. 1. (Lehrbücher und Monographien aus dem Gebiete der Exakten Wissenschaften. Chemische Reihe—Band 9.) Pp. 300. (Basel und Stuttgart: Birkhäuser Verlag, 1955.) 37.50 Swiss francs; 37.50 D. marks.

THE insecticide DDT has been well known for a dozen years, though latterly a number of new synthetic compounds have emerged to challenge its superiority in various fields. However, there are not so many new types of insecticide as may appear from the lists of names; most of the newcomers belong either to the chlorinated terpene group (to which γ-benzene hexachloride is toxocologically allied) or to the phosphoric acid series. The discovery of a new class of insecticides is, in fact, rare. DDT marked such an advance that it is generally considered to have opened a new era of pest control, and it continues to be widely and satisfactorily used for many purposes.

A few years ago Dr. P. Müller, of Geigy, who was largely concerned with its discovery, decided that the time was ripe for a new monograph on DDT. The first volume has now appeared, in the form of a symposium of five sections, by Swiss, British, Austrian and Swedish authors. Four of the contributions are in German and one in English, with summaries in the alternative language. One or two books on DDT have already been published, though none recently. About the best was that by T. F. West and G. A. Campbell (1950); but these authors admitted delays in publication, and their text contains no reference later than 1946. (To remedy the defect, they added a supplement of more than eight hundred references for 1947 and 1948, which gives some idea of the enormous output of papers on the subject.)

The present monograph takes the account up to 1953; but the more recent work has added very little to the data on physical and chemical matters that comprise Section 1, by Dr. Müller himself. Section 2, by Prof. V. B. Wigglesworth, summarizes our knowledge on the mode of action of DDT, this contribution being by far the most generally interesting. It begins by considering factors involved in the contamination of insects by DDT and continues to the final minutæ of intoxication—so far as they are known. This lucid survey integrates the findings of 137 papers, 80 per cent of them published between 1946 and 1951. After reading it, we still do not know how DDT kills; but the possibilities are greatly narrowed.

The remaining contributions are of a more practical nature and deal with the use of DDT against particular types of pests. Section 3, by Dr. E. Bernfus, of Vienna, deals with the control of stored product pests, especially those of breweries. In view of the serious importance of toxic residues, methods are described for determination of DDT traces in food. Section 4, by Dr. O. Walchli, of St. Gallen, Austria, discusses the use of DDT for protecting woollen textiles against clothes moths and carpet beetles. The final section, on control of forest insect pests, is by Dr. V. Butovitsch, of Stockholm. It gives full details of spraying and dusting by aircraft and from the ground against the woodland pests. No information on control of agricultural and horticultural pests is given in this volume, nor are insect disease vectors or parasites mentioned; no doubt they will receive attention in the next volume.

J. R. BUSVINE

GEOPHYSICAL RESEARCH IN NORTH AMERICA

Advances in Geophysics

Edited by H. E. Landsberg. Vol. 2. Pp. x+286. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 7.50 dollars.

THIS volume is the second in a series. It contains five essay reviews, each approximately fifty pages in length, dealing with recent advances in various branches of geophysics. Each is by a separate author or authors; but the whole volume is edited by H. E. Landsberg, of the United States Weather Bureau, assisted by a small advisory committee. As might be expected of a composite work of this kind, the style and quality of the different contributions vary considerably; but, on the whole, a high standard is maintained. Each essay contains a good bibliography, and author and subject indexes are provided.

In the first essay, on advances in radar weather, J. S. Marshall, W. Hitschfeld and K. L. S. Gunn (McGill University) describe typical precipitation patterns and give an outline of the ways in which quantitative data can be derived from radar signals. In "Methods of Objective Weather Forecasting", by I. I. Gringorten (Air Force Cambridge Research Center, Cambridge, Mass.), various objective methods of weather forecasting are classified, and the success and future objective of such systems discussed. W. J. Pierson, jun. (Department of Meteorology and Oceanography, New York University), discusses wind-generated gravity waves, and gives an outline of mathematical methods of describing such waves. This can be applied to analyse the form and motion of actual waves at sea. Some practical methods of observing and forecasting are also considered. In the essay on geological chronometry by radioactive methods, J. L. Kulp (Lamont Geological Observatory, Columbia University, New York) gives brief accounts of the lead, carbon-14, strontium, potassium, helium and ionium methods of radioactive dating and also reviews some other potential methods. The final essay is on earthquake seismographs and associated instruments, by H. Benioff (Department of Seismology, California Institute of Technology). The progress in design during the past twenty-five years is illustrated by short descriptions of some thirty different types of seismograph; advances in methods of recording and time-keeping are also summarized.

The whole volume is written and produced in North America. It is not surprising, therefore, to find that most of the work described has been carried out either in the United States or Canada. Within this field, the reviews are fairly complete; but they could be improved if research carried out in other countries were more fully treated. As a series of reviews of recent geophysical work in North America, this book can be strongly recommended, and future volumes in the series will be awaited with interest.

B. C. BROWNE

SOME RECENT EXPERIMENTS IN FRICTION*

Friction of Solids at High Speeds

MOST of our earlier experiments on friction have been conducted at low or moderate speeds of sliding which come within the range that an engineer might normally use. These speeds rarely exceed 30 m./sec. (70 m.p.h.). It has been shown[1] that, even at low speeds, a localized heating can occur and cause a softening or melting at the summits of the surface irregularities. On prolonged sliding this causes surface flow and polishing, but the heating is concentrated mainly in the very small regions of intimate contact. At low speeds the friction of metals is due primarily to adhesion and shearing of the contact regions, and the surface damage is characteristic of this. More recently, we have been studying the behaviour of surfaces sliding at very high speeds—up to 1,000 m./sec. (2,200 m.p.h.). An engineer would certainly regard such speeds as excessive; but they are reached, for example, by the copper driving-band of a shell when it is leaving the muzzle of a gun.

In the laboratory these speeds can be achieved by using a technique which has been developed by Beams[2] for his ultracentrifuge. A steel sphere is suspended by an electromagnet, its top is illuminated and the shadow falls on a photoelectric cell. If the ball sinks, the current in the magnet will increase; if it rises, it will decrease so that the ball is held in a stable vertical position. It can be caused to spin by a rotating magnetic field. If the ball is surrounded by an evacuated glass chamber, the forces opposing its rotation will be very small and it will soon reach a very high speed (more than a million revolutions a minute for a steel ball of $\frac{1}{8}$ in. diameter). The speed is limited only by the rupture strength of the ball. As the top of the ball is illuminated, an etch mark can be detected by means of a photomultiplier cell and transmitted to a cathode-ray oscillograph or an electronic frequency meter and recorder. The sliding speed can thus be measured accurately.

In our friction experiments the fast-spinning ball rubs against three symmetrically arranged vertical surfaces as shown schematically in Fig. 1. All three are initially in such a position that they cannot interfere with the ball during its acceleration. Two of them are mounted rigidly, and when the desired speed is reached, a spring is released which pushes the third surface against the ball and thus moves it a very short distance sideways until it also touches the other two stationary surfaces. A measurement of the deceleration under the known load gives the coefficient of friction.

If the spring-operated surface is withdrawn, the ball returns quickly to its free-spinning position and can be slowed down in such a way that the high-speed wear marks are not further damaged. In this way it is possible to measure the friction and to study the physical processes occurring over a great range of speeds, up to 1,000 m./sec. The results plotted in Fig. 2 were obtained with a steel ball-bearing of $\frac{1}{2}$ in. diameter rubbing against surfaces of copper (curve *A*) and of bismuth (curve *B*). The load was 20 gm. The friction was measured immediately after the sphere had touched the surfaces. Both metals show a very great decrease in the coefficient of friction as the speed is increased. The low values measured at high speeds are striking, since the surfaces are clean and in a moderate vacuum.

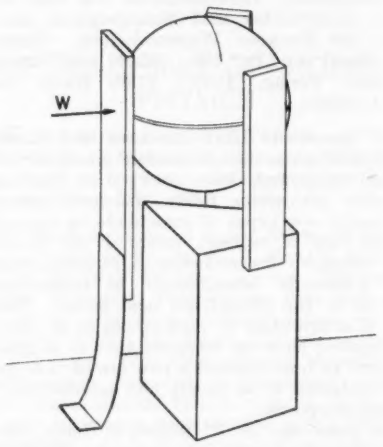


Fig. 1. Arrangement for measuring friction at high speeds (load *W*)

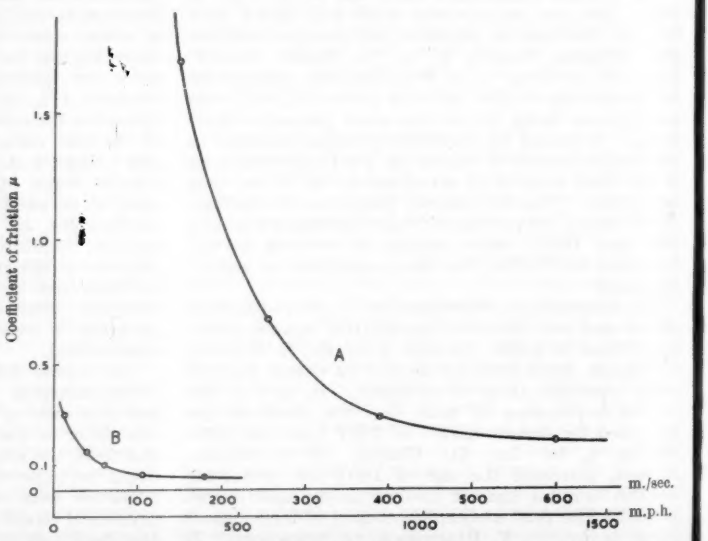
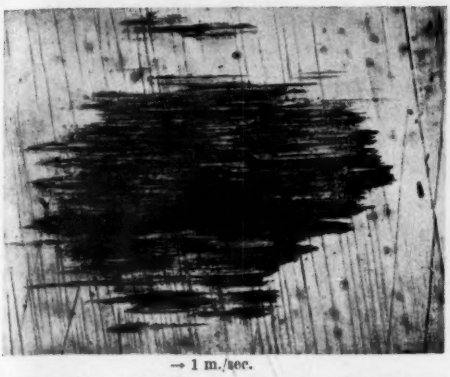


Fig. 2. Friction of metals at high speeds: (*A*), steel on copper (m.p. 1,083° C.); (*B*), steel on bismuth (m.p. 271° C.). Load 20 gm.

* From a Friday Evening Discourse given at the Royal Institution, London, on May 6.

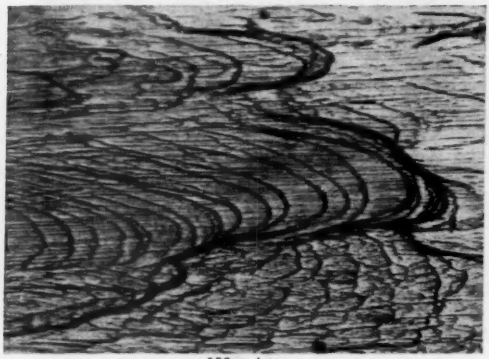


→ 1 m./sec.

Fig. 3(*a*). Slow-speed sliding wear on copper, showing normal abrasion (× 160)

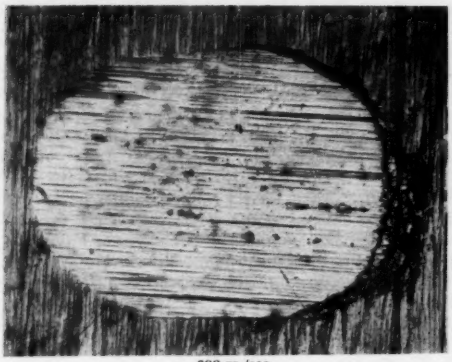
→ 150 m./sec.

Fig. 3(*b*). Medium-speed sliding wear on copper, showing flow of metal (× 160)



→ 150 m./sec.

Fig. 3(*c*). Medium-speed sliding wear on copper, showing flow of metal (× 160)



→ 600 m./sec.

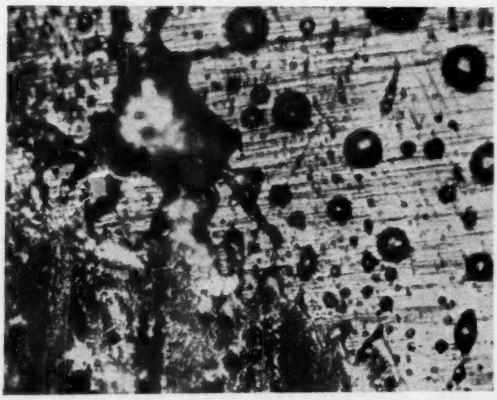
Fig. 3(*d*). High-speed sliding wear on copper, showing surface flow (× 160)

Clearly the physical processes involved must be quite different from those which prevail at normal speeds of sliding.

Fig. 3 illustrates surface damage of copper which is being rubbed by a steel ball. When the speed is only a few metres per second (Fig. 3*a*) the copper surface shows the characteristic marks of abrasion. One would expect a high friction, and in a vacuum, once the oxide films are removed, seizure occurs. At 150 m./sec. (Fig. 3*b*) the surface damage is clearly of a new type. The copper is flowing, and a considerable amount of it (up to 0·5 mgm.) is picked up by the steel ball. The coefficient of friction is reduced to about 1·5, but a deceleration from this speed would rapidly lead to seizure. The flow of copper after more prolonged rubbing under the same conditions (150 m./sec.) is illustrated in Fig. 3*c*. If the sliding is faster (Fig. 3*d*), the surface layers of copper approach the molten state and may act as a lubricant in the same way as water on ice (see below). The viscosity of molten copper is of the same order of magnitude as that of water. The coefficient of friction at 600 m./sec. falls to the very low value of 0·2. As soon as the rubbing surfaces are separated, the copper solidifies to form a relatively smooth shiny surface. The wear per unit distance slid is very much less than that observed at normal speeds.

With bismuth, which is a bad thermal conductor and has a low melting point, the surface melting and low friction should occur more readily. Fig. 4 leaves no doubt about the melting of the bismuth surface at 300 m./sec. Solidified drops of molten metal are scattered around the wear track. The friction is found to be nearly as low as that of ice when a water film is present.

It is clear that the resistance to the sliding of metallic surfaces is not constant but can fall to very low values at high speeds. At these speeds the wear



300 m./sec. →

Fig. 4. High-speed sliding wear on bismuth. Portion of crater edge (× 160)

per unit distance of sliding is also very much less than that observed at normal speeds. There is evidence, both from the frictional behaviour and from the examination of the surface, that this behaviour is due to the formation of a thin layer of molten metal which acts as an effective lubricant film.

F. P. Bowden
E. H. Freitag

Friction on Snow and Ice and the Development of some Fast-Running Skis

We may draw an analogy between the mechanism of the friction of metals at very high speeds and that of skiing. Ice is an interesting solid from the frictional point of view because its friction can be lower by an order of magnitude than that of other crystalline solids. Osborne Reynolds[3] suggested that the low friction in skating was due to a water film formed by pressure melting. Some years ago an experimental study[4] of the friction of snow and ice was made at the Jungfraujoch Research Station. The friction of cold snow or ice is very high; it is only near 0° C. that the friction is low. The experiments supported the view that the low friction is due to surface melting. They showed, however, that pressure melting is a factor only at temperatures very close to 0° C. and with slow-moving surfaces. If the sliding speed is appreciable and the temperatures are below 0° C., the local surface melting is produced, not by pressure melting but by the frictional heating of the sliding surfaces. Under the conditions which exist in skiing and sledging, it is this frictional heating and melting which is the major factor responsible for the low friction. Experiments with sliders of different thermal conductance were in harmony with this view. These early experiments were carried out with miniature sliders.

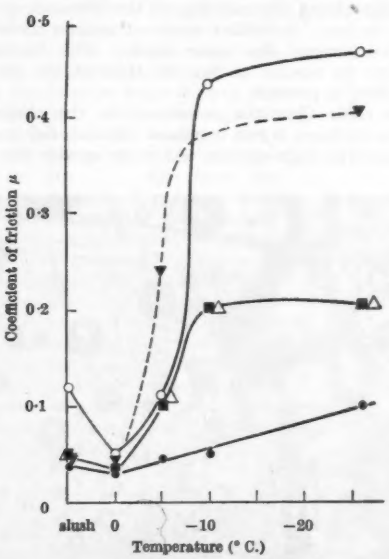


Fig. 5. Influence of temperature on the static friction of real ski: ○—○—, ski lacquer; ▼—▼—, paraffin wax; ■—■—, Norwegian wax; △—△—, Swiss wax; ●—●—, polytetrafluorethylene

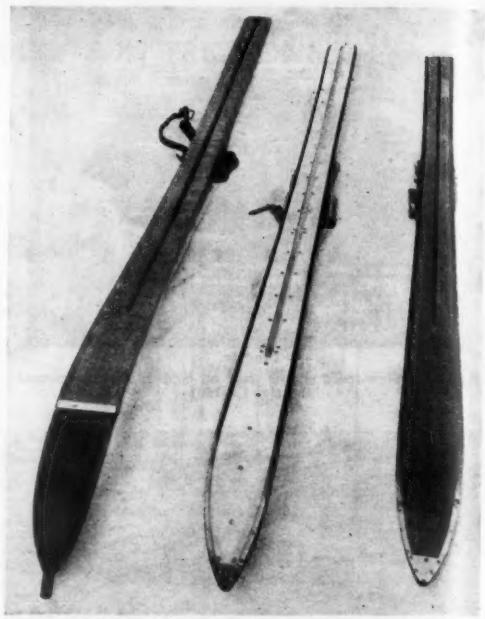


Fig. 6

Recently[5], the experiments have been extended to real skis, and a study has been made of the behaviour of some new plastic materials sliding on ice and snow. The experiments support the earlier conclusions that the low friction on snow and ice is due to a surface melting produced by the friction-heating of the sliding skis. The rubbing of the ski at the localized points of contact of the snow crystals causes a surface melting. Very cold snow or ice behaves like any other crystalline solid. At low temperatures the static friction (or the slow-speed friction) of ice is high, and it is not until the ski begins to slide at an appreciable speed that the friction falls to a small value. This is illustrated by Table 1.

Table 1. Influence of Speed on Friction: on Ice at − 10°C.

Ski surface	Coefficient of friction: Static	At 3 cm./sec.	At 5 m./sec.
Waxed wood	0·20	0·18	*c.* 0·02
Lacquered wood	0·40	0·36	*c.* 0·03
'Perspex'	0·35	0·32	*c.* 0·03
Aluminium	0·38	0·34	*c.* 0·04

The influence of temperature on the static friction of skis on snow is illustrated in Fig. 5: most of these surfaces (except polytetrafluorethylene) are standard ones used in skiing. Two important points which may be noticed from this figure are, first, that the friction for all these surfaces falls as the snow warms up and is at a minimum at 0° centigrade; and, second, the very low friction given by the plastic material polytetrafluorethylene under all conditions. An account of the general frictional behaviour of this material has been given elsewhere[6]. Methods used for attaching the plastic to the skis are shown in Fig. 6. The behaviour of polytetrafluorethylene on snow is due partly to its inherently good frictional properties and partly to the fact that it is not wetted by water. There is evidence that the frictional behaviour of different solids sliding on snow is

Table 2. TIMED DESCENTS: COMPARISON OF WAXED SKI WITH NEW SKI OF POLYTETRAFLUORETHYLENE

(a) Crystalline spring snow; air temperature 5° C.; snow temperature 0° C.; gentle slope of length 700 ft. (tracked)

Weight on ski (lb.)	Time of descent (sec.): Conventional ski with Norwegian wax and paraffin	New ski of polytetrafluorethylene
168	61	42
140	83	54

(b) New snow fallen a few hours previously; air temperature 10° C.; snow temperature 0° C.; unloaded ski (tracked)

Details of slope	Time of descent (sec.): Conventional ski, with ski lacquer	New ski of polytetrafluorethylene
Gentle, 20 m. long	10	6
Steeper, 30 m. long	6	3

influenced by the contact angle which the water film makes with the surface. With polytetrafluorethylene this contact angle is very high (126°), and it remains high even after prolonged sliding on snow. This is appreciably higher than the contact angle observed on waxed surfaces which have been rubbed on snow. The experiments suggested that polytetrafluorethylene might have interesting possibilities as a skiing surface, and several pairs of skis have been coated with it and tried out in the Alps under a variety of snow conditions during the past three years. Some timed straight-run descents under controlled conditions have also been made. The results are quite striking, some typical experiments being illustrated in Table 2.

It is clear that skis of polytetrafluorethylene are considerably faster under these conditions. They are easy to ski on, because they give a low uniform friction even when running on patchy snow. They should have useful applications not only to skiing but also to sledging and to aircraft landing, particularly on very cold, very wet or difficult snow and ice.

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[1] Bowden, F. P., and Ridler, K. E. W., *Proc. Roy. Soc.*, A, **151**, 610 (1936).
[2] Beams, J. W., *J. Washington Acad. Sci.*, **37**, 221 (1947).
[3] Reynolds, O., "Paper on Mechanical and Physical Subjects, 2" (Cambridge University Press, 1901).
[4] Bowden, F. P., and Hughes, T. P., *Proc. Roy. Soc.*, A, **172**, 280 (1939).
[5] Bowden, F. P., *Proc. Roy. Soc.*, A, **217**, 462 (1953). See also Hawksley Lecture, *J. Inst. Mech. Eng.*, **2**, 86 (1955).
[6] Bowden, F. P., and Tabor, D., "Friction and Lubrication of Solids" (Oxford: Clarendon Press, 1954).

SOLAR ECLIPSES AND THE IONOSPHERE

IONOSPHERIC measurements at the time of solar eclipses may be expected to yield useful information on problems such as the nature of the ionizing radiation and its distribution on and outside the visible solar disk, on theories of the formation of the ionosphere and of recombination processes within the various layers. It has long been established that the primary ionizing source of the *E* and *F*1 layers of the ionosphere is solar ultra-violet light. This conclusion is amply confirmed both by long-term measurements and by results obtained during solar eclipses. However, in the case of region *F*2 the source is less clearly defined; eclipse effects in this region are often complex and the interpretation of the observations ambiguous. Certain aspects of eclipse phenomena in all the ionospheric regions were discussed at a symposium on "Solar Eclipses and the Ionosphere" held in the rooms of the Royal Society, London, during August 22–24. The symposium was organized by the Mixed Commission on the Ionosphere and sponsored by the International Council of Scientific Unions. Some twenty-five British and fifty-five overseas delegates participated.

Opening the symposium, Mr. J. A. Ratcliffe presented a general survey of ionospheric eclipse phenomena and discussed the eclipse effects to be expected in a simple Chapman-type layer. Eclipse results for region *E* have been reconciled with the predictions of simple theory by supposing that the process of electron loss is recombination-like with an effective coefficient $\alpha' \simeq 10^{-8}$ cm.^{3} sec.$^{-1}$. In most cases it has also been necessary to suppose that the intensity of the ionizing radiation is not uniform over the solar disk, and furthermore that a measurable fraction originates outside the visible disk. In the case of region *F*1, eclipse estimates of α' lie between 5 and 9×10^{-9} cm.^{3} sec.$^{-1}$, and for this region there is again evidence for enhanced radiation from the same areas which contribute to the *E*-layer ionization. In the *F*2 layer complex eclipse effects are often observed, and here it is clear that consideration must be given to the influence of movements in the layer during the eclipse. An interesting phenomenon which has received attention during recent eclipses is the temporary appearance of a new critical frequency between the *F*1 and *F*2 critical frequencies. It has been suggested that this might correspond to a separate layer, the so-called *F*1½ layer, due to some special process of electron production. However, it can be shown that if the electron loss coefficient decreases upwards, then the appearance, during an eclipse, of a point of inflexion on the *h'f* curve between the *F*1 and *F*2 layer critical frequencies is to be expected.

Mr. C. M. Minnis discussed eclipse results for region *F*2 obtained at Khartoum, Singapore, Slough and Inverness during eclipses of 1952, 1954 and 1955 and stressed the desirability of always computing the electron density/true height profile, since deductions based only on critical frequency variations can be misleading.

Prof. S. Chapman outlined the development of ideas concerning a possible corpuscular eclipse effect in the ionosphere. The observed delay of about one day between certain solar disturbances and terrestrial magnetic storms indicates that the solar particles have an average speed of about 1,000 miles/sec., and for this speed the corpuscular eclipse might be expected to occur about two hours before the optical eclipse. This difference in time would, of course, result in a considerable difference in position on the earth between the optical and corpuscular eclipses. As far back as 1919 Chapman and Milne pointed out that a speed of 1,000 miles/sec. seemed quite inadequate for particles to reach the 100-km. level, and it is now believed that if there are any corpuscular eclipse effects these may be expected to be weak and to affect only a high layer in the ionosphere. Prof. Chapman also outlined the theory of the effect of an

eclipse on the Earth's magnetic field. The reduction in the electron and ion content of the ionosphere during a solar eclipse reduces the conductivity; this modifies the electric current intensity and hence affects the transient variations in the earth's field. In general, the magnetic effect of an eclipse may be expected to be quite small—the precise magnitude and nature will depend on the location of the observing site with respect to the electric current systems in the ionosphere. At stations near the foci of these systems the eclipse effect may be expected in the vertical force, whereas in equatorial latitudes it should appear in the north horizontal force.

Recent successful measurements of geomagnetic effects during a solar eclipse were described by Mr. J. Egedal. Records of magnetic declination from fourteen observatories in Europe showed small but quite definite effects during the eclipse of June 30, 1954. The magnitude was of the order to be expected if the ionospheric currents concerned flowed near the level of region *E*. Dr. T. Nagata presented similar results for observations in Japan during the eclipse of May 9, 1948. In this case it was found that the magnitude of the changes in the east component were consistent with calculations based on the observed eclipse decrease in electron density in the *E*-layer.

One session was devoted to a discussion of present solar knowledge with particular reference to ionospheric studies. Prof. C. W. Allen showed that long-period ionospheric data for regions *E* and *F* require a quiet component from the whole Sun together with a component associated with centres of activity. Dr. M. A. Ellison discussed some ionospheric effects of solar flares, and Prof. D. R. Bates presented a short summary of present views concerning the theory of layer formation. The *D* layer is now believed to be due to photoionization of nitric oxide by Lyα, the *E* layer to X-rays centred mainly near 40 A., and the *F*1 and *F*2 layers partly to longer X-rays and partly to ultra-violet ionization of atomic oxygen. Mr. M. Ryle and Dr. J. P. Hagen respectively presented summaries of knowledge concerning the solar corona and chromosphere as deduced from solar radio noise studies.

A session on recombination in the ionosphere was introduced by Prof. D. R. Bates, who emphasized that recombination takes place through a complex variety of processes. For the higher layers the basic mechanism is probably dissociative recombination. In the case of the *D*-layer the position is still open. To explain the very large recombination coefficients for the *D*-layer, the mechanism might be negative ion recombination, it might be ordinary dissociative recombination or the process might involve complex ions. Prof. J. Sayers briefly outlined laboratory experiments on recombination processes now in progress in the University of Birmingham.

Measurements of effective recombination coefficients deduced from solar eclipse ionospheric observations were presented by Mr. C. M. Minnis, Dr. O. Burkard and Dr. K. Rawer. Mr. Minnis showed how the effective recombination coefficients deduced from eclipse measurements depend critically on assumptions concerning the amount of residual radiation at totality. He also showed that although it is often difficult to give accurate estimates of α'_E and α'_{F1}, it is possible, both from measurements of the normal diurnal variations in fE and $fF1$ and from eclipse observations, to obtain reliable estimates of the ratio α'_E/α'_{F1}. Dr. Rawer stressed the errors likely to be involved in evaluating effective recombination coefficients by applying an over-simplified theory to eclipse observations. The usual assumptions of monochromatic ionizing radiation, of an isothermal atmosphere and of simple recombination processes are not satisfied, and in presenting future ionospheric results he suggested that data should be given for parameters which are independent of any special theories. Dr. Burkard considered ionospheric data for the eclipse of February 25, 1952, and showed that if the results are interpreted not in terms of the usual simple theoretical equilibrium equation but in terms of a modified equation in which layer conditions are not assumed to be isothermal, then there is no necessity to assume a non-uniform distribution of the sources on the solar disk as had been done by other workers.

Mr. W. R. Piggott discussed eclipse observations of vertical-incidence ionospheric absorption at Ibadan in 1952 and showed that eclipse changes in the absorbing region and in regions *E* and *F*1 all appeared to indicate similar (irregular) distributions of the emission of the ionizing radiation from the Sun. Interesting eclipse observations on the lowest ionosphere were described in papers by Dr. K. Weekes and by Dr. E. A. Lauter.

In the final session of the meeting, Dr. S. D. Gossner directed attention to some unusual geometrical conditions pertaining to the solar eclipse of October 23, 1957. These conditions result from the fact that the axis of umbra will pass near the surface of the Earth without actually touching it and the central lines will intersect the ionosphere twice. For vertical soundings this second intersection will take place in the general area of the Falkland Islands Dependencies.

The principal points which would appear to have arisen from discussions at this symposium are the following. In the case of region-*E*, some 10–15 per cent of the ionizing radiation comes from beyond the visible solar disk. The uncertainty concerning the actual magnitude of this residual radiation means that there is corresponding uncertainty about the effective recombination coefficients deduced from eclipse observations. In interpreting eclipse results it is also very important to consider what is the appropriate value for the index m in the expression $fE \propto (\cos\chi)^m$ (χ = solar zenith angle). In general, experimental results do not fit the value predicted by simple theory, namely $m = 0{\cdot}25$, and during the discussions a number of possible causes for the observed variations in m were brought to light. In the case of region *F*1, the above difficulties are again all present. It is clear that, in eclipse observations on this region, changes in the electron density/true height profile and not merely changes in the critical frequency $fF1$ must be considered. In the case of region *F*2, similar profiles must also be calculated, and the discussions also clearly brought out the importance of movements in this region. Several speakers referred to the appearance of the $F1\frac{1}{2}$ trace during eclipse observations, and although some results suggested that this phenomenon is confined to places of low magnetic dip and to eclipses of large magnitude, it was not clear that this is always the case.

During the symposium, limitations of time only permitted the presentation of summaries of a few of the fifty papers submitted. These papers, together with the discussions, will shortly be published in a single volume by the International Union for Scientific Radio.

W. J. G. Beynon

GEORGIUS AGRICOLA (1494–1555)

By JOAN M. EYLES

IF one were to ask a well-informed student of the history of science to name the three most important scientific books published in the first half of the sixteenth century, his first choice would certainly be the "De Revolutionibus Orbium Coelestium" by Copernicus, published in 1543. Next he would probably select the "De Humanis Corporibus Fabrica" by Vesalius, which also appeared in 1543. He would probably hesitate before making a third choice, and might possibly decide in favour of one of the great herbals, perhaps that of Leonard Fuchs, published in 1542. If reminded of Agricola, he might answer that this author's famous "De Re Metallica" was not published until 1556, and was, in any event, like the "Pirotechnia" of Biringuccio (1540), essentially a work on technology rather than science. It is unlikely that he would be acquainted with the contents of Agricola's earlier book, "De Ortu et Causis Subterraneorum", published in 1546, which consists of several treatises, the first of which gives the book its name. Yet it can be justly claimed that this book, which contains almost all that Agricola wrote on mineralogy and geology, laid the foundations on which these sciences were built, and entitles Agricola to be ranked equally with Copernicus and Vesalius as one of the really great sixteenth-century scientists.

In many well-known histories of science, the name of Agricola either does not appear at all, or is mentioned only in connexion with his great work on mining and metallurgy, "De Re Metallica". Wolf's "History of Science, Technology and Philosophy" is an exception, for its author does record some of the geological opinions of Agricola contained in the "De Ortu". These have been extracted from the excellent notes given by H. C. and L. H. Hoover in their well-known translation of the "De Re Metallica"[1]. However, Wolf, while realizing the importance of the views which he quotes, makes no attempt to appraise Agricola's standing among the scientists of the early sixteenth century.

Lack of appreciation of Agricola's "De Ortu" is not surprising, for in most general histories of science the evolution of geology, the one subject that forms a bridge between the biological and physico-chemical sciences, is allotted a very minor role. It must be admitted that this is largely the fault of geologists themselves, who by neglecting a rewarding field of research, have failed to arouse general interest in the subject.

The neglect of Agricola by modern geologists, particularly those of the English-speaking world (for his own countrymen have always been more appreciative of his merits), was recognized by the Hoovers when they wrote in 1912: "The wider interest of the members of the medical profession in the development of their science than that of geologists in theirs has led to the aggrandizement of Paracelsus, a contemporary of Agricola, as the first in deductive science. Yet no comparative study of the unparalleled egotistical ravings of this half-genius, half-alchemist, with the modest sober logic and real research and observation of Agricola, can leave a moment's doubt as to the incomparably greater position which should be attributed to the latter as the pioneer in building the foundation of science by deduction from observed phenomena. Science is the base upon which is reared the civilization of to-day, and while we give daily credit to all who toil in the superstructure, let none forget those men who laid its first foundation stones. One of the greatest of these was Georgius Agricola".

Agricola's life has been related in some detail by Hofmann[2], and more recently by Hartmann[3]. His surname was, in the vernacular, Bauer, but he had adopted the Latin version by the time his first book, a small Latin grammar, was published in 1520, and he retained this form thereafter. He was born in Glauchau, in the Saxon Erzgebirge, at a time when the leaven of the Italian Renaissance was already working in the universities of northern Germany. Therefore, when he went to the University of Leipzig in 1514, he was able to study Greek as well as Latin, first under the instruction of an Englishman, Richard Croke, who later became lecturer in Greek at Cambridge, and then under Petrus Mosellanus, father of humanism in Saxony. Agricola spent four years at Leipzig and after graduating was appointed vice-principal of the town school at Zwickau, a place of some importance near his home. The town council of Zwickau clearly appreciated the brilliance of the young teacher, for in 1519 they opened a new trilingual school, in which Greek, Latin and Hebrew were taught, with Agricola as rector. Three years later, however, he returned to Leipzig as lecturer, assisting Mosellanus; and about this time he began to interest himself in the study of medicine and philosophy. A desire to hear the most famous doctors and to read the texts of Galen in the original Greek took him next to Italy. Here he spent two years, mostly in Venice, where he was closely associated with the Aldine Press, and assisted in editing the great collected edition of Galen's works in Greek, which it issued in 1525.

On returning to Zwickau in 1526 he was, so he wrote later, burning with a desire to know more of the mines and minerals so abundant in the Erzgebirge. This region had for the previous fifty or sixty years been the scene of intense mining activity. Agricola had graduated in Italy as a doctor of medicine, and in 1527 he accepted the post of *Stadtarzt* (town physician) in Joachimsthal, a new mining town in Bohemia, on the south side of the Erzgebirge. There he was in a most favourable position for following up his new interests. The mines at Joachimsthal, at that time producing much silver, supplied, some 450 years later, the pitchblende used by the Curies in their researches on radioactivity. They were first opened up in 1516, and by the time Agricola arrived the population of the district was already some 10,000, nearly all miners and officials.

The first fruit of Agricola's interest in the mines was a small volume entitled "Bermannus sive de re metallica", published at Basle in 1530 by the Froben Press, which also published most of his later works. There is a foreword, praising the book, by the great humanist, Erasmus of Rotterdam. The text takes

the form of a conversation between three learned men, one skilled in mining matters; and it contains descriptions of many minerals and ores. Its publication added to the reputation of Agricola, already renowned as a classical scholar, and his friends eagerly awaited further works on the subject from his pen.

In 1530 he gave up his post at Joachimsthal, and a few years later returned to Saxony, settling at Chemnitz, another mining centre, where he remained until his death in 1555. He was appointed *Stadtarzt* and in later years was several times *Bürgermeister*. Apart from a minor, though still valuable, work on weights and measures, he published nothing further until 1546, when the results of his many years of research in geology and mineralogy appeared in "De Ortu et Causis Subterraneorum".

Each treatise is preceded by a dedicatory letter to some friend or patron, and these letters often contain interesting information about Agricola himself. In one he lists the works he has yet to publish. Of these, some appeared in 1550, but the "De Re Metallica", the great work on mining and metallurgy so long awaited by his friends, was not issued until 1556, four months after his death. In the interim he had been called on to serve his patron, Duke Maurice, who became Elector of Saxony in 1547, in a diplomatic capacity. Maurice was a Protestant, and Agricola had remained a staunch Catholic during the stormy years of the Reformation. However, his writings reveal a tolerant outlook, and no doubt his wide knowledge and experience were valuable to the Elector, who sent him on various missions to the Emperor Charles V, Ferdinand, King of Hungary, and other princes. The rich mines of Saxony and Bohemia played an important part in the economy of Europe at that time, and probably Agricola's specialized knowledge made him a valuable intermediary. The Elector died in 1553, and was succeeded by his brother Augustus, who continued the patronage Agricola had previously enjoyed from Maurice. The text of the "De Re Metallica", dedicated to Maurice and Augustus, appears to have been completed by the end of 1550, but was long delayed, probably by the preparation of the several hundred woodcuts. In 1553 the completed book was sent to the Froben Press; but it was March 1556 before it appeared in print. Meanwhile, Agricola had died on November 21, 1555, from a sudden fever that lasted only four days. His position as a Catholic *Bürgermeister* in a fiercely Protestant town must have been anomalous, yet it is sad to learn his family were not allowed to bury him in the cathedral of Chemnitz, the town in which he had been so distinguished a citizen. Four days after his death, his body was conveyed to Zeitz, some forty miles away, and interred there, in the Catholic cathedral.

New editions and translations of his books, particularly the "De Re Metallica", continued to appear at intervals in the succeeding centuries, and a reprint of the Hoover translation was issued only a few years ago. No English translation of the "De Ortu" has yet appeared. For this reason it has been eclipsed in fame by the better known and beautifully illustrated "De Re Metallica". Nevertheless, it has every right to be regarded as a major scientific classic. Agricola brought to a study of the Earth and its constituents the touchstone of his own experience, and assayed the theories of earlier authors in the crucible of his profound knowledge of their writings, often finding the 'ore' to be of poor quality.

The "De Ortu" contains four new works and a reprint of the earlier "Bermannus". Though each treatise is self-contained, and the titles may appear unrelated, yet in fact their arrangement follows a methodical plan. The first book, "De Ortu et Causis Subterraneorum", discusses the physical phenomena affecting the earth, in particular the part played by water; and Adams[4] comments that Agricola's description of the earlier stages of erosion might well have been written in the twentieth century. Another of the topics in this treatise is the origin of ore deposits, and here Agricola's reasoned view, that ores were deposited from solutions in channels or fissures that had originated after the containing rocks, constitutes a remarkable advance on all previous speculations. The next two treatises deal with the constituents of the Earth. The first ("De Natura eorum quae effluunt ex Terra") discusses those which are vapours or liquids, and the second ("De Natura Fossilium") discusses solid bodies, for which he uses, for the first time, the word 'fossil'. The use of this term to describe all substances dug out of the earth continued for well over two centuries, and it is only since the beginning of the nineteenth century that it has been restricted to fossil organisms. The "De Natura Fossilium" is the first attempt at a systematic mineralogy, and in it Agricola describes many minerals for the first time. His classification of these 'fossil' bodies has been described by Adams, but a fact of considerable historical importance, which does not appear to have been commented on by chemists, is his recognition of the difference between chemical compounds ('mista') and mixtures ('composita'). The former, he states, are composed of two or more simple fossil bodies, so intimately mixed that "even in the smallest part there is not wanting any substance contained in the whole", and inseparable except by fire; whereas the components of the 'composita' can be separated not only by fire but also by water and sometimes by hand ("De Natura Fossilium", 1546, p. 185). This clear statement was made more than a century before that of Boyle in the "Sceptical Chymist". Boyle, incidentally, was familiar with the works of Agricola, whom he described as "the most classick author we have about mines".

Agricola's fourth treatise, on old and new mines and minerals ("De Veteribus et Novis Metallis"), contains a wealth of information concerning the situation of mines and the metals obtained from them. It is worth mentioning here that he gives a list of places in Cornwall where tin was worked, and refers to the meeting of miners from Cornwall and Devon every seven or eight years on "Hengenstendonus mons" (Hingston Down, twelve miles north-west of Plymouth) to discuss their affairs. This is later mentioned by Camden.

The "De Ortu" was translated into Italian in 1550, and other Latin editions appeared in 1558, 1612 and 1657; but the most useful edition for the student is the German translation, with many notes, which appeared during 1806–10. Unfortunately, this is as scarce as the earlier editions. An English translation would be most valuable and attract to the book the attention it undoubtedly merits. Meantime, one can say there is no question of placing Agricola among the great—he already stands there—but, unfortunately, almost unrecognized.

[1] London, 1912, reprinted 1950.
[2] Hofmann, E., "Dr. Georg Agricola" (Gotha, 1905).
[3] Hartmann, H., "Georg Agricola" (Stuttgart, 1953).
[4] Adams, F. D., "The Birth and Development of the Geological Sciences" (Baltimore, 1938).

ENERGY EXPENDITURE BY MAN

IT is notorious that there are fashions in science. The discovery of a new approach in any branch of work tends to direct attention to a restricted aspect: not until the cream has been skimmed by means of the new technique is a balance restored. The study of nutrition is peculiarly liable to such tendencies: the discovery of vitamins ushered in a fruitful and major preoccupation with the fundamental biochemical processes of cellular metabolism, and so did the appreciation of the importance of trace elements. Indeed, the earlier interest in 'proximate principles' was well-nigh ousted, and the dictum, "look after the calories in food and the other constituents will look after themselves", fell into a probably well-deserved disrepute.

In nutrition, however, there is a very special sense in which a balance of interest must be preserved. As individuals and as communities we must balance the intake and expenditure of energy: the energy we give to the world in the work of our muscles and in the heat of our bodies we must recapture from food. If expenditure exceeds income, the body of the individual wastes away, and on a national scale famine is abroad in the land; if intake is greater than expenditure, the individual will suffer from the lethal nuisance of obesity, and in the community there will be a glut and, in default of adequate methods of storage, a waste of food. Thus it is not sufficient to concern ourselves solely with the intake of food, to make available what we believe to be a safe margin in excess of requirements. If it comes to the point that we have to adjust our expenditure to income, we shall have to know how best to use the energy available to us. To combat obesity, the usual practice is to recommend a restriction in intake of food. But a human being is not a mere machine. He has genetical roots stretching far into the past when his body was adjusted to a life of hard physical toil. To restrict the intake of food is to throw his physiological processes out of gear, and it is better, if the food is available, to adjust the balance by increasing exercise. That demands some knowledge of the time-course of energy expenditure in different activities.

At the beginning of this century there was considerable interest in human calorimetry, both direct and indirect, this interest being well illustrated in the successive editions of Graham Lusk's classical book "The Elements of the Science of Nutrition" (1906–31). For the reasons already mentioned, interest in calorimetry lapsed but now shows signs of a revival, in part due to the introduction of new apparatus and in part due to a realization that, after all, calories do matter. It was not inappropriate, therefore, that the Nutrition Society should arrange this year a symposium on the "Energy Expenditure by Man", which was held in the National Institute for Medical Research, Mill Hill, on October 15.

The first paper at the symposium, on the development of experimental methods for determining the expenditure of energy by man, was given by C. G. Douglas. He explained briefly the theoretical bases of calorimetry and followed the changes in technique, primarily in indirect calorimetry, from the early days of Regnault and Reiset[1] in 1849 to the present time. There have been no changes in fundamental principles and surprisingly few variants in the technical approach to the problem. The determination of the expenditure of energy depends on measurement of the gaseous exchange between a living organism and the atmosphere which surrounds it. The earlier techniques tended to be elaborate and cumbrous. The animal or human being was enclosed in a chamber through which air was circulated by a pump. The oxygen used by the animal was replaced from outside the system, and carbon dioxide absorbed within the system. Such techniques restricted gravely the living activities which could be studied, although brave attempts were made to study muscular activity in man by placing ergometers within large chambers. Indirect calorimetry was first successfully freed from the shackles of cumbrous laboratory equipment by Dr. Douglas's use of a large gas-tight bag to collect the expired air. Such a bag could be worn on the back, giving the subject very considerable freedom to carry out normal activities. The idea came to Dr. Douglas when watching an old-fashioned 'magic lantern': the gases for the lime-light were stored in large bags. No advance on this Douglas-bag technique appeared until 1940, when German workers introduced the Kofranyi–Michaelis respirometer (Max-Planck respirometer), which is a reversion to an old principle[2]. The expired air is passed through a light, dry flowmeter worn on the back like a haversack. As the expired air passes through the meter, small samples are withdrawn and collected for subsequent analysis.

Accurate methods of indirect calorimetry demand accurate gas analysis. Attempts have recently been made to replace the Haldane and similar types of apparatus by rapid physical methods; but these have not yet proved satisfactory.

H. S. Wolff described his light-weight integrating motor pneumotachograph[3], the principle of which is the same as that of the Max-Planck respirometer, except that the flowmeter employs a method new to calorimetry. The pressure of the expired air lifts a diaphragm from off the exit tube of the meter, and the lift of this diaphragm is proportional to the flow. The excursion of the diaphragm, by means of an electro-mechanical integrating device, allows the volume of expired air to be read on a veeder counter. In the latest models the volume of air expired can be recorded at a distance by transmitting impulses from the meter. A small pump draws a sample of expired air into a polythene bag, and the air in this bag is afterwards analysed. The pneumotachograph, with its associated equipment, is light, offers little back pressure to breathing and records faithfully rates of flow far in excess of those found during maximum expiration in strenuous exercise: with a face mask it can be worn for hours without distress, and thirst can be slaked with the mask in position. Observations have been made on men in the Army performing hard physical exercises. The way is thus open for a very complete survey of the expenditure of energy over long periods and in all walks of life.

In the afternoon session O. G. Edholm dealt with the value of measuring expenditure of energy in nutritional studies. These in the past have depended almost wholly on dietary surveys. Such surveys give reasonably accurate information on the income of energy, but give no indication of how the energy

is spent. A review of the few surveys in which both intake and expenditure were measured shows good agreement on the average over a period of days. In a recent careful study[4], however, no correlation was found between individual daily intake and expenditure of calories: there was no correlation even between the mean expenditure of the group on any one day and the intake on that day. There was a correlation between the mean expenditure on one day and the intake two days later. Here is revealed an aspect of metabolism that is but imperfectly understood. The human body is able apparently to adjust its intake of food to an expenditure of energy which took place days before. Indeed, there is evidence that such belated adjustment may extend over a much longer period.

R. Passmore discussed the time-course of the daily expenditure of energy by human beings. With increasing mechanization in industry, with '*Homo sapiens*' becoming '*Homo sedentarius*', we tend, in our estimation of the severity of work, to place undue emphasis on the nature of the employment. Lying, sitting and standing occupy a large part of the twenty-four hours even for an active man. Roughly 500 Calories are spent asleep in bed, and 1,500 Calories in recreation and off-duty activities; and this seems to hold whether the occupation involves light or heavy work. Should there be a diminution in expenditure of energy in the period of recreation, as there may well be with advancing years, and if the appetite is not correspondingly curbed, obesity will rear its ugly head.

J. V. G. A. Durnin had the rather thankless task of talking about the influence of age on expenditure of energy. The report on calorie requirements by a committee of the United Nations Food and Agriculture Organization[5] suggests that the intake of calories at twenty-five years of age should be decreased by 7·5 per cent for every ten years beyond that age. There is very considerable criticism of this proposal; but the original suggestion, and all criticisms thereof, suffer alike from a practically complete lack of known facts. Information is badly needed in all communities where shortened working-hours for the young make an increasing demand for labour from the elderly. How do advancing years affect muscular efficiency, and what load can we place with safety on the age group 55–70 years? We do not know. A short pilot experiment showed that elderly men used more energy in walking than did younger men. The elderly, however, spent no more energy when the exercises were confined to the muscles of the arms. There is no reason why the metabolic processes in the muscles of the elderly should not be as efficient as those in younger people; perhaps neuromuscular control is not so efficient.

H. R. Noltie dealt with the expenditure of energy by athletes, a subject on which information is scanty: with the older techniques it was scarcely feasible to find with any degree of accuracy the expenditure of energy during the more strenuous and competitive forms of exercise. Golf is known to make comparatively modest demands on expenditure of energy, about 5 Cal./min.; fast walking, due to swinging of the arms, can be expensive in energy and even more expensive than slow running: sustained running at speed may demand 25 Cal./min. Swimming makes very great demands, and so does skiing. But the ski, from the point of view of energy expenditure, is, in all circumstances, more economical than the snow-shoe. It is possible, too, to estimate the influence of style and of length of stride in running. The 'fast start' is costly in terms of energy expenditure. Thus, it is not beyond the bounds of possibility that athletes, trainers, and spectators with a financial interest in the outcome will all have ultimately to discuss athletic contests in relatively pure physiological terms.

General discussion after the final paper tended to focus on obesity, on its causation and on the very real problem of the control of body-weight: restrict the food intake and we are unhappy, increase exercise and we become all the hungrier. What is the cause of fatigue? What causes muscle soreness after unwonted severe exercise? We have no answers. These may come by future closer integration than in the past between the physiological and biochemical approaches to the problems of nutrition.

[1] Regnault, V., and Reiset, J., *Ann. Chim.* (*Phys.*), **26**, 299 (1849).
[3] Kofranyi, E., and Michaelis, H. F., *Arbeitsphysiologie*, **11**, 148 (1940).
[3] Fletcher, J. G., and Wolff, H. S., *J. Physiol.*, **123**, 67*P* (1954).
[4] Edholm, O. G., Fletcher, J. G., Widdowson, Elsie M., and McCance, R. A., *Brit. J. Nutr.*, **9**, 286 (1955).
[5] "Calorie Requirements" (Washington, D.C.: F.A.O., 1950).

OBITUARIES

Dr. W. K. Spencer, F.R.S.

Dr. William Kingdon Spencer, whose death occurred at Ipswich on October 1 at the age of seventy-six, was a prominent figure in the world of education who, notwithstanding exacting official duties, found time to carry out important researches on fossil starfishes and other Echinodermata. The son of J. F. Spencer, formerly of Parkstone, Dorset, he was born at Barrow-on-Soar, and spent his boyhood at Upper Hopton, Yorkshire, where his father had been appointed headmaster of the village school. From Batley Grammar School (where he was a contemporary of Sir Owen Richardson) he gained a demyship in natural science at Magdalen College, Oxford, where he proceeded in 1898 after studying for a short time at the University of Marburg. Graduating in 1902 with first-class honours in zoology, he was awarded the Burdett-Coutts Scholarship and began his researches on fossil invertebrates.

For a year (1903–4) Spencer held the post of lecturer and demonstrator in the University Department of Geology at Oxford, under W. J. Sollas. His career as a teacher of palæontology soon terminated, however, for in 1904 he was appointed to a post under the Board of Education, and before long became the Board's chief examiner in science. In 1914 he was appointed inspector of schools for East Suffolk, where he guided the educational programme until his retirement in 1938 and was largely responsible for the very effective reorganization and the extension of the schools of that area which followed the Hadow Report of 1926. On retirement he lived for a time in southern France and continued with his research work in the University of Montpelier. When France was overrun by the German army he escaped to Portugal and proceeded to South Africa, where he resumed educational work. After the War he again retired to France, first re-visiting Great Britain in 1953.

Spencer's first echinoderm paper, published by the Royal Society in 1904, dealt with the Palæozoic genera *Palaeodiscus* and *Agelacrinus*, to the investigation of which he applied Sollas's technique of serial sections.

He then turned to the Cretaceous Asteroidea, completing (1905–7) for the Palæontographical Society the monograph on that group which had been begun by W. Percy Sladen in 1891–93. The evolution of these forms was the subject of a subsequent paper in the *Phil. Trans. Roy. Soc.* (1913). His major work was his monograph of the British Palæozoic Asterozoa, ten parts of which were published by the Palæontographical Society between 1914 and 1940, when the War made further progress impossible. Spencer's last work, in which he described and discussed the earliest known starfishes, which occur in the Lower Ordovician of southern France and Bohemia, was published in 1951 by the Royal Society.

Spencer's work was concerned largely with ancient and often indifferently preserved fossils; but he was an adept at getting the most out of his material and always regarded the subjects of his researches primarily as animals which had once lived in harmony with their environment, and the functional significance of every structure of which demanded interpretation. The skilful reconstructions of these animals and their organs, well depicted under his guidance by his artist, F. T. Jones (an Ipswich art master), are a notable feature of his papers. He received his Oxford doctorate and the Lyell Award of the Geological Society of London in 1918, and in 1931 was elected to the fellowship of the Royal Society.

L. R. Cox

Mr. R. B. Pilcher, O.B.E.

THE name of Richard Bertram Pilcher, who died at his home in Northwood on October 1 in his eighty-second year, will remain indelibly impressed on the records of two distinct professional organizations—the Royal Institute of Chemistry and the Chartered Institute of Secretaries. A native of Patrixbourne, near Canterbury, he was appointed clerk to the Institute of Chemistry in 1892 and became successively assistant secretary (1894), secretary (1895) and registrar and secretary (1900–45). Pilcher had known all the presidents from 1877 onwards, and from his youth completely identified himself with the profession and with its interests and aspirations. His tall, lean and dignified figure, with a hint of the ascetic, due more to the delicate state of his health in early manhood than to any avoidance of the pleasures of life, was well known in scientific and official circles for many decades.

During the First World War the Institute became the chief agency whereby the various ministries and Government departments obtained chemists, and Pilcher, then secretary to the Glass Research Committee, was in constant demand. After the War he interested himself in the re-settlement of officers and other careers matters, serving on committees of the Ministry of Labour. He was appointed O.B.E. in 1920. He served as honorary secretary of the Chemical Council from its inception in 1935 until 1943. He became a member of the Parliamentary and Scientific Committee in 1935, and a vice-president in 1943. In 1952 the Institute paid tribute to his long service and abiding interest in the profession by admitting him as one of its first honorary Fellows.

An avid reader, fond of honest labour, and prone to contemplation, his pen never rested long. Several of his compilations became standard reference works, passing through a number of editions. Among these were "Official Chemical Appointments" (1906); the joint work "What Industry Owes to Chemical Science" (1918); and "The Profession of Chemistry" (1919). Having a keen interest in the history of chemistry, and particularly in chemical biography and iconography, he acquired a mass of manuscript material and a well-known collection of prints.

A Fellow of the (then) Institute of Secretaries in 1897, Pilcher served it as a member of council from 1908, as vice-president (1924–26) and as president (1926–27). He introduced the system of registered studentship, and was ever pleased to think that many thousands of young people had thereby increased their knowledge and worth to the community. He was also a past chairman of council of the Association of Men of Kent and Kentish Men.

Pilcher was intensely human and loved all growing things. This, perhaps, provides a clue to the main interests of his life—children and flowers; students and the history of science; the nurturing and service of two rapidly expanding professional organizations: in these matters his years did not weary him nor diminish his ardour. He is survived by his widow, Violet Frances, two sons and a daughter.

F. W. GIBBS

NEWS and VIEWS

Royal Society: Award of Royal Medals

H.M. THE QUEEN has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows: Sir Alexander Todd, professor of chemistry, University of Cambridge, for his distinguished work in organic chemistry; Prof. V. B. Wigglesworth, Quick professor of biology, University of Cambridge, for his distinguished experimental contributions of outstanding value to many aspects of insect physiology.

Electronic Engineering at Liverpool: Prof. J. D. Craggs

THE Robert Rankin chair of electronic engineering in the University of Liverpool has been filled by the appointment of Dr. J. D. Craggs, formerly reader in electronic engineering. Dr. Craggs graduated in 1937 in the University of London and, after a year's research in the Mechanical Engineering Department at King's College, London, he was awarded a Department of Scientific and Industrial Research grant to enable him to work under the direction of Sir Charles Ellis on the development of a high-voltage accelerator for nuclear research. This work was carried out in the Research Department of the Metropolitan-Vickers Electrical Co. at Trafford Park, Manchester. In 1940 Dr. Craggs joined the research staff of this Company and continued to work on the accelerator until 1941, when he became concerned with the development of high-power spark modulators for radar. During 1944–45 he spent six months in the University of California, Berkeley, on studies of collision process connected with the uranium fission programme. In 1945 he returned to the Metropolitan-Vickers Research Department and was responsible for the construction of a 20-MeV. betatron. He also carried out work on

the characteristics of electric sparks. In 1948 he joined the University of Liverpool as senior lecturer in electrical engineering and in 1949 he was promoted reader. Prof. Craggs's recent researches have been concerned mainly with electrical discharges. He has been an active member of the Institute of Physics and has been largely responsible for the formation of the Liverpool and North Wales Branch of the Institute. He is a member of a Ministry of Supply committee dealing with the application of electronic techniques to ballistic problems.

Geology at St. Andrews : Dr. Charles F. Davidson, O.B.E.

Dr. C. F. Davidson has been appointed to the chair of geology in the University of St. Andrews, consequent upon the retirement in 1954 of Prof. D. E. Innes. Dr. Davidson is a graduate of that University (University College, Dundee), where he took his degree with first-class honours in geology and mineralogy; afterwards he was awarded the D.Sc. degree for a thesis on the geology of a part of South Harris, Outer Hebrides. Dr. Davidson has had a distinguished career with the Geological Survey of Great Britain and the Museum of Practical Geology, which he joined in 1934, and from which he has resigned his appointment as district geologist in charge of the Atomic Energy Division. He was first concerned with preparing exhibits for the new Museum in South Kensington which was opened in 1935, and his duties under Dr. W. F. P. McLintock widened his experience, especially in mineral determination. During the Second World War his attention was turned to preparing reports on overseas geology for the intelligence departments of the Services, particularly for the Naval Intelligence Division; in 1941 he compiled a report on uranium resources. It was this latter work which led to the setting up in the Geological Survey, with Dr. Davidson in charge, of a special department for investigations upon radioactive ores. Towards the end of 1945, the responsibility for research and development on atomic energy passed from the Department of Scientific and Industrial Research to the Ministry of Supply, and in 1954 to the United Kingdom Atomic Energy Authority. The work of the Survey's Atomic Energy Division, undertaken in conjunction with these various bodies, was directed towards the discovery and evaluation of radioactive mineral deposits capable of furnishing uranium and thorium ores to the British market. Dr. Davidson's success was marked both in field-work and in the development of appropriate laboratory techniques. In the course of his very extensive travels, he has visited areas in remote parts of the world to assess the economic potentialities of these important ores, and in several cases he has contributed to the scientific understanding of their genesis.

Visit of Russian Scientists to Britain

The Royal Society, in association with the Soviet Relations Committee of the British Council, has arranged for a party of leading Russian scientists to visit Britain. The delegation is led by Academician A. N. Nesmeyanov, president of the Academy of Sciences, Moscow; other members of the delegation include Academician I. G. Petrovsky, mathematician and rector of the University of Moscow; Academician A. L. Kursanov, plant physiologist; Academician V. A. Kargin, physical chemist; and corresponding member of the Academy P. Ya. Kotchina, hydraulics engineer. Academician Nesmeyanov is a distinguished chemist and was director of the Institute of Organic Chemistry of the Academy of Sciences. He became president of the Academy of Sciences in 1951, and has been a member of the Supreme Soviet of the U.S.S.R. since 1950. In addition to a number of functions at the Royal Society, the delegation is to visit Cambridge (November 18–20), where they will be the guests of Lord Adrian at Trinity College; Edinburgh (November 21–22), where their programme is being arranged by Sir Edward Appleton, principal and vice-chancellor of the University; and Oxford (November 25–26), where Sir Cyril Hinshelwood, foreign secretary of the Royal Society, is arranging a programme of visits. The Parliamentary and Scientific Committee will receive the delegation in the Houses of Parliament, and visits have been arranged to the National Physical Laboratory and Rothamsted Experimental Station. The delegation will be the guests of the Royal Society at its anniversary dinner on St. Andrew's Day, November 30.

Visit of British Atomic Scientists to the U.S.S.R.

A delegation from the United Kingdom Atomic Energy Authority is on a six-day visit to the Soviet Union. Owing to heavy commitments in Great Britain, Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell, has not been able to take part in the visit; the delegation is therefore being led by Dr. B. F. J. Schonland, deputy director at Harwell. The other members of the delegation are: Dr. Willis Jackson, representing the Royal Society and the British Nuclear Energy Conference; Mr. B. D. Goodlet, head of the Engineering Research and Development Division, Harwell; Dr. J. V. Dunworth, head of the Reactor Physics Division, Harwell; Dr. D. W. Fry, head of the General Physics Division, Harwell; Mr. A. A. Smales, head of the Analytical Chemistry Group, Harwell; Dr. L. Rotherham, head of research and development, Industrial Group, Atomic Energy Authority; and Mr. J. C. C. Stewart, director of the Technical Policy Industrial Group, Atomic Energy Authority. The visit is the result of an invitation for a British delegation to visit the Soviet Union addressed to Sir John Cockcroft at Geneva in August by the Soviet delegation to the United Nations Conference on the Peaceful Uses of Atomic Energy. Fifteen Soviet scientists were among the delegates to that Conference which visited Harwell last August. The programme of the visit to the U.S.S.R. includes an atomic power station, a powerful phasotron (an accelerating machine), the Lebedev Institute and the Institute of Geochemistry and Analytical Chemistry of the Academy of Sciences of the U.S.S.R.

Astronomical Clock in York Minster

A memorial to airmen who fell while operating from bases in Northumberland, Durham and Yorkshire during the Second World War was unveiled in York Minster by H.R.H. the Duke of Edinburgh on November 1. The memorial contains an astronomical clock, designed by Dr. R. d'E. Atkinson and made under his direction in the workshops of the Royal Observatory. There are two main dials. On the west is a "Zodiacal" dial which shows the apparent motions of the sun. A large convex disk represents the horizon, as seen from York facing south, and a sun rises from behind this, passes across the sky and sets behind the disk again. The times of rising and setting are accurate to within one minute. The rays surrounding

the model sun are of such a length that when they disappear behind the disk, twilight is approximately ending. In addition to its daily motion, the sun is shown to move along a circle representing the ecliptic and it thus rises to the appropriate elevation at any time of year. Solar time may be read from this dial and Greenwich Mean Time is shown on a dial below. The equation of time may thus be obtained as the difference between the dials. The other side of the memorial carries an "Astral" dial. This shows the daily apparent motion of the northern circumpolar stars. Sidereal time may be read from this dial and it is also shown on dials on the "Zodiacal" side converted into degrees. The clock depicts events appropriate to the latitude and longitude of York, and is intended to give a picture of the heavens as seen by a navigator in an aircraft over the city. It is housed with a Book of Honour in a walnut frame designed by Prof. A. E. Richardson and ornamented by Mr. Maurice Lambert and Mr. H. J. Stammers.

Atmospheric Pollution in Great Britain

In moving the second reading of the Clean Air Bill in the House of Commons on November 3, the parliamentary secretary to the Ministry of Housing and Local Government, Mr. W. F. Deedes, said that the Government believes that the necessary replacement in the black areas scheme of about 19 million tons of house coal by smokeless fuels can be gradually achieved over fifteen years. The Government has accepted the Beaver Committee's recommendations that the most efficient practicable method of removing sulphur should be used in power stations in or near populated areas, and research into this problem is being pressed forward. He emphasized that the rate of progress may be limited by the difficulty of finding the technical staff required by local authorities for the discharge of their additional responsibilities. Mr. Deedes announced the Government's acceptance of the Beaver Committee's recommendation for the establishment of a Clean Air Council, and in replying on the debate the Minister of Housing and Local Government said that it is the Government's intention to make the Bill as effective, tight and strong as possible consistent with what is practicable. He is prepared to consider the inclusion of a general introductory clause stating that clean air is a national policy, though he does not think it would add anything to the Bill, and also to make the appointed day, for the purpose of the seven-year period allowed for the modification of equipment, the day after the passing of the Bill. In regard to research, he emphasized the work already being carried out by the Department of Scientific and Industrial Research and referred to the construction by the Central Electricity Authority of a full-scale pilot plant for extensive trials at a power station. Mr. Sandys promised to consider sympathetically at a later stage any amendments likely to make the Bill a more effective instrument to eradicate a great social and economic evil, a menace to public health and a source of waste and destruction.

Scientific Library Centre in London

In a written answer to questions from three members of the House of Commons on November 1, Mr. J. R. Bevins, parliamentary secretary to the Ministry of Works, as representing the Lord President of the Council, stated that the proposals for improved scientific libraries referred to in the eighth annual report of the Advisory Council on Scientific Policy are at present being considered by the Departments concerned. As these projects involve considerable capital expenditure, and the reference library scheme is bound up with wider questions affecting the Patent Office, Mr. Bevins regretted that he was not yet able to make a statement. In a further reply on November 8, Mr. Bevins said that the capital cost of a new building to house both the Patent Office and its library, extended to provide a National Reference Library, was estimated at rather more than £2,000,000.

Economics of the Press in Great Britain

The broadsheet on the "Balance Sheet of the Press", issued earlier this year by Political and Economic Planning (*Planning*, **21**, No. 384; 1955. Pp. 14; 2*s*. 6*d*.), is of particular interest in view of the recent announcement by the Board of Trade that control of newsprint in Great Britain is to end next year. The broadsheet directed attention to great changes which are impending in the organization of the British Press. It is the first of a series which sets out to examine these problems, and it throws some light on the critical reception of the Government's decision by the Newsprint Supply Company, which is desirous that some form of voluntary rationing should continue to safeguard the weaker papers, as the ending of control does not mean that supplies will then be adequate to meet demands. On this point the broadsheet suggests that the high price of newsprint is likely to prevent daily newspapers from reaching their pre-war size, although twelve-page papers are probable. A considerable rise in world demand is anticipated during the next decade, and substantially increased production is planned in spite of the fact that world supplies are severely limited in the immediate future; the provision of more newsprint during the next few years depends on renewed contracts with Canada, although, later, increased supplies may be available from non-dollar sources.

Between 1937 and 1947 the circulation of London and provincial dailies rose by more than ten million and that of Sunday newspapers by fourteen million, compared with an increase in population in the period of 2·6 million. Magazines and periodicals had a circulation of about twenty-six million in 1938 and probably more than forty million in 1952. Press advertising in 1954 was estimated at about £160 million out of a total advertising expenditure of £280 million, and, of this, 38 per cent was in provincial newspapers, 24 per cent in national newspapers, 21 per cent in magazines and periodicals and 16 per cent in trade and technical journals. The provincial newspapers, posters and the smaller-circulation magazines are expected to lose most to television advertising. As regards the future, costs in all departments of newspaper production are expected to continue to rise, and the total circulation of the national papers is probably near its limit. Total sales revenue is unlikely to be increased by raising the price of the daily paper; unaccompanied by a larger paper, it could cause a substantial fall in sales. In view of competition from television advertising, substantial increases in advertising-rates are unlikely, nor, while papers remain at their present size, can the 33 per cent of their space devoted to advertising be increased. Much could be done, however, to eliminate waste of man-power and materials, and the broadsheet suggests that both management and labour should pay greater attention to the increase of efficiency in this way.

Cortisone and Corticotrophin

The November issue of *The Practitioner* is devoted to a consideration by a number of authorities of the value and dangers of the hormones cortisone and corticotrophin (ACTH). Until recently, supplies of both these drugs in Great Britain were not adequate; but now there are good reasons for believing that supplies of them will soon be enough to satisfy all needs. They are, in most instances, used empirically, because we do not yet know enough about how they act; but their value in carefully selected cases is very apparent from Dr. C. L. Cope's article on their pharmacology and from the other articles by experts who discuss their uses for treating chronic rheumatic diseases, gout, rheumatic fever, certain diseases of the skin, the eye, the endocrine glands and blood, and for asthma, or as an aid to surgery. To summarize these articles in a brief review is impossible, and would be dangerous; indeed, it would not be wise to epitomize, or take out of the context, the scope and content of Prof. E. J. Wayne's contribution on the dangers and complications of the use of these drugs. Nevertheless, an indication of the general position can be gathered from the opinion expressed on the first page of the issue that "the practitioner will not go far wrong if he continuously bears in mind the advice given by Prof. Wayne that, in cases of doubt, it is better to be cautious in deciding to give these drugs". Prof. Wayne, however, also says that fifteen years ago the text-books "devoted pages to the side effects of sulphonamides, but they are still used in considerable quantities and with good effect".

The South African Museum, Cape Town (1855–1955)

The centenary of any organization is an appropriate time to publish details of its origin and progress. The South African Museum at Cape Town has thus just published an admirable booklet to celebrate that event (pp. 23+4 plates; 1955). As with so many museums of the early and middle nineteenth century, it was founded on the pattern of the British Museum in London. It is indeed fortunate in that as early as 1855 the trustees realized that the Museum should be a place of education combined with recreation and also a centre of research on the natural products of South Africa. It was not until 1897 that the Museum acquired a second and more adequate building, and now it is rightly suggested that the centenary should be marked by additional galleries. This would enable the greatly increased collections to be more properly preserved and the display to be modernized. The booklet gives a brief description of the principal acquisitions since 1855, and an important section deals with the field-work that the Museum has been able to organize.

British Nuclear Energy Conference: Meeting in London

The British Nuclear Energy Conference, which has been formed by the Institutions of Civil, Mechanical, Electrical, and Chemical Engineers and the Institute of Physics (see *Nature*, June 11, p. 1023), will hold its first meeting in the form of a lecture symposium, to be held at the Institution of Civil Engineers (Great George Street, London, S.W.1) on November 30 (2.15–8.15 p.m.) under the chairmanship of Sir Christopher Hinton. Lectures will be delivered as follows: the United Kingdom Atomic Energy Project (Sir John Cockcroft); the place of nuclear energy in United Kingdom power development (V. A. Pask and J. C. Duckworth); the use of research reactors in nuclear power development (H. J. Grout); and health and safety in a nuclear power industry (A. S. Maclean and Dr. W. H. Marley). The papers will be published in the new *B.N.E.C. Journal* of the Conference (see *Trans. Inst. Chem. Eng.*, **33**, No. 2; Oct. 1955). Attendance at the symposium will be confined to members of the five member bodies concerned, and those who wish to attend should write as soon as possible to the secretary of their particular professional body.

Atomic Energy Exhibit at British Industries Fair

The "Atoms for Britain" exhibition, shown at Geneva during the Conference on the Peaceful Uses of Atomic Energy, will be seen for the first time in Britain at next year's British Industries Fair. It is to be presented by the U.K. Atomic Energy Authority and will be a major feature in the electrical and electronics sections of the Fair at Olympia, London, during April 23–May 4. The exhibition, which covers 7,000 sq. ft., will show Britain's progress in harnessing nuclear power and in using atomic energy in industry, agriculture and medicine. The research carried out at Harwell will be illustrated by large-scale models, photographs and diagrams. One of the models will be of DIDO, the 'heavy-water' research reactor which will be completed by next summer. A model of Britain's first atomic power station now being built at Calder Hall, Cumberland, will also be on show. This station, which is scheduled to start feeding electricity into the national grid at the end of next year, is the first of twelve to be built in Britain during the next ten years. Another model on display will be of a more advanced and experimental type of power unit now under construction at Dounreay, Caithness. The uses of radioactive isotopes will also be shown.

First International Congress on Documentation of Applied Chemistry

The first International Congress on Documentation of Applied Chemistry will be held in London during November 22–25, at the Institut Français, Queensberry Place, South Kensington. The Congress is under the patronage of the International Union of Pure and Applied Chemistry, and the president of honour is Lord Cherwell, Dr. Lee's professor of experimental philosophy in the University of Oxford, who will open the first session. The Congress is confined to one particular field, namely, applied chemistry, and although not the first of its kind it is the first conference at an international level at which a serious attempt has been made to bring together librarians and information officers, on one hand, and the applied chemists, who use the information they supply, on the other. On November 23 two sessions will be held on the international and national scenes, respectively, with Dr. L. H. Lampitt and Sir Alfred Egerton as chairmen. On November 24 two sessions will be devoted to particular problems, with Prof. E. Velander (Sweden) and Prof. A. Nasini (Italy) as chairmen. On the last morning, the Congress, with Prof. W. Albert Noyes (United States) as chairman, will look to the future. At the final session in the afternoon there will be an open discussion on the problems raised during the various sessions and a paper giving a summary of the proceedings; a valedictory address will be given by Sir William Ogg, director of the

Rothamsted Experimental Station and chairman of the Congress Council. A registration fee of 2 guineas will be charged, payable to the Honorary Secretary of the Congress at 56 Victoria Street, London, S.W.1, from whom further information can be obtained.

Aluminium in Shipbuilding

A SYMPOSIUM on "The Use and Welding of Aluminium in Shipbuilding", organized by a joint committee representing the Institute of Welding, the British Welding Research Association, the Institution of Naval Architects, the British Shipbuilding Research Association and the Aluminium Development Association, will be held in the Weir Lecture Hall of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1, during December 7–8. The symposium will consist of four sessions on, respectively, welding processes and techniques; materials and design; applications; and applications and economic factors. Admission to the symposium for the discussion of the papers to be presented is free. The papers will be published before the symposium, and a complete set can be obtained on payment of a registration fee of 4 guineas. The full proceedings will be published later and offered for sale by the Institute of Welding. Further information can be obtained from the Secretary, Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1.

International Wool Textile Research Conference

THE proceedings of the International Wool Textile Research Conference held in Australia in August and September (see *Nature*, October 15, p. 712) are to be published in five volumes. The Commonwealth Scientific and Industrial Research Organization is making a special pre-publication offer at a price of £A10 per set of five volumes, or £A2 per volume for Volumes *A–D* and £A4 for Volume *E*. The titles of the volumes are: Volume *A*, "Histology of Wool and Hair and of the Wool Follicle"; Volume *B*, "Chemical Physics and Physical Chemistry of Wool and Proteins"; Volume *C*, "Chemistry and Biochemistry of Wool Proteins, Peptides and Amino Acids"; Volume *D*, "Physics of Wool and other Viscoelastic Fibres"; Volume *E*, "Wool Technology". The ordinary price will be £A25 for the five volumes, and the reduced price is possible only for orders which are received before printing commences. Order forms are available from: Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2.

University of Glasgow

THE following have been appointed lecturers in the University of Glasgow: G. W. Crosbie (biochemistry); N. G. Waton (experimental pharmacology); N. Grassie (macromolecular chemistry); J. Aitchison (mathematics); H. A. de Borde, B. H. Bransden, D. Dixon and W. S. C. Williams (natural philosophy); I. A. Boyd and Ann B. MacNaught (physiology), and L. M. Kellas (veterinary histology and embryology). Dr. A. Bhati has been appointed to an Imperial Chemical Industries, Ltd., fellowship in chemistry. A course in nuclear engineering, consisting of forty lectures and about twenty-five hours of practical work, is now available in the University for final-year students in engineering; it is being run by the Department of Natural Philosophy. A new petrochemical laboratory has been added to the Geology Department, and some of the space vacated by the Chemistry Department in the main University building is being taken over as an extension by the Geography Department. For the present session, 343 new students (273 men and 70 women) have been admitted to the science departments, compared with 287 in 1954. In the University as a whole, the total number of matriculated students has increased by about a hundred to 5,679.

University of London

THE title of professor of biology in the University of London has been conferred on G. E. H. Foxon in respect of his post at Guy's Hospital Medical School, and that of professor of geography in the University of London on A. E. Smailes in respect of his post at Queen Mary College. The following have been appointed to University of London readerships tenable at the institutions indicated: Dr. P. M. Butler, zoology at the Royal Holloway College; Dr. S. W. Hinds, public health at the London School of Hygiene and Tropical Medicine; N. P. W. Moore, mechanical engineering at the Imperial College of Science and Technology; and Dr. R. K. S. Wood, plant pathology at the Imperial College of Science and Technology.

Announcements

DR. J. F. LOCKWOOD, master of Birkbeck College, has been elected vice-chancellor of the University of London for the remainder of the university year 1955–56, in succession to Prof. H. R. Robinson, who has resigned on medical grounds.

THE Ellen Browning Scripps Fellowship for 1955–56 has been awarded to Dr. Gordon W. Ballmer. The Fellowship is awarded by the San Diego Zoological Society, California, and is for research in any field of biology, a stipend of 3,500 dollars for a ten-month period being provided, together with full facilities for work at the San Diego Zoological Gardens. Dr. Ballmer, who is a graduate in zoology of the University of Michigan, Ann Arbor, will study carbohydrate metabolism in the Testudinata.

MR. S. L. HUTHNANCE, at present county agricultural officer for Berkshire, has been appointed deputy provincial director for the West Midland Province of Britain, in succession to Dr. D. H. Robinson, who was recently appointed provincial director.

THE ninth meeting of the European Association of Exploration Geophysicists will be held in London, at Church House, Westminster, during December 7–9. Further information can be obtained from the British representative, J. E. R. Wood, British Petroleum Co., Ltd., Kirklington Hall, nr. Newark, Notts, or from the Association itself at 30 Carel van Bylandtlaan, The Hague, Holland.

THE Scientific and Technical Group of the Royal Photographic Society is arranging a conference on "Photographic Science and Technique", to be held on December 3, in the Arthur Worthington Hall of the University of Manchester (Dover Street, Chorlton-on-Medlock, Manchester 13). Seven papers will be read. It is hoped to make a visit in the evening to the Shirley Institute. The conference will be open to the public. Further information can be obtained from R. E. Withrington, 49 Kensington Avenue, Manor Park, London, E.12.

IN his review of Dr. Pollitzer's book on plague, which appeared in *Nature* of October 1, p. 615, Dr. E. Ashworth Underwood wrote on line 7: "Dr. Pollitzer, the only surviving author". Dr. Wu Lien-teh is in fact alive and still very active in other capacities.

PHYSICAL CHEMISTRY OF ENZYMES

FARADAY SOCIETY DISCUSSION

THE Faraday Society held a discussion on "The Physical Chemistry of Enzymes" during August 10–12 in the Department of Physiology, University of Oxford. At the suggestion of the chairman of the organizing committee, Prof. F. J. W. Roughton, the time of the meeting was arranged so that it followed the International Congress in Biochemistry. As a result, a large number of biochemists from the Congress were able to be present at the Faraday Society discussion, and the total attendance was 244. Twenty-nine papers concerning a wide field of enzyme topics were discussed, and a great many valuable contacts were made between enzyme biochemists and physical chemists interested in the enzyme field. The chair at the opening session was taken by the president of the Society, Prof. R. G. W. Norrish, and the introductory paper was given by Dr. M. Dixon, whose lucid exposition of the present position of the field set the pattern for the subsequent discussion.

Dr. Dixon pointed out that of approximately four hundred and fifty known enzymes, all of them protein molecules, about a hundred have been obtained in crystalline form. He noted that enzyme studies include both protein properties and catalytic properties, and that most of the papers before the meeting were concerned with the latter aspect. A great many enzyme reactions fall into the general class of group transfer reactions, and the requirements of specificity suggest in many cases a close fit between enzyme and substrate over a patch 15–20 A. in diameter. Such an active patch might be associated with a particular folding of polypeptide chains in the surface of the protein, giving rise to a characteristic arrangement of side-chains. Passing to problems of kinetics, Dr. Dixon discussed the various developments of the basic Michaelis–Menten equation, which supposes enzyme (E) and substrate (S) to combine to form a complex (ES) which decomposes to the product (P), with the rate-constants given:

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_3} P$$

He referred to the various ways of identifying the rate-determining step for the overall enzyme reaction, later treated in detail by several contributors to the discussion. He showed how the effect of pH on enzyme velocity may lead to a knowledge of the pK of ionizing groups in the active site, and also described the use of isotopes in investigating the sequence of bonds broken in enzyme reactions.

Characterization and Physical Properties

The papers in the section on "Characterization and Physical Properties" were concerned entirely with soluble enzymes. It is well known that a crystalline protein is not necessarily homogeneous. In cases where two or three species are present, they may frequently be separated by electrophoresis or sedimentation, the first technique depending on differences in charge (therefore ionizing groups) and the second on molecular weight. A single homogeneous protein diffusing across a boundary according to Fick's law sets up a concentration gradient/distance relationship of Gaussian type, but a mixture of proteins leads to departures from this curve. A paper by R. L. Baldwin, L. J. Gosting, J. W. Williams and R. A. Alberty (Wisconsin) described first how the diffusion method has been increased in sensitivity until 0·1 per cent impurity is detectable in crystalline albumins, using an interference-fringe method. A study of the reversible spreading of electrophoretic boundaries can detect differences of one electronic charge between protein molecules.

V. Massey, W. F. Harrington and B. S. Hartley (Cambridge) have 'labelled' enzymes with an organic dye molecule, and compared the inhibiting effect of the dye with measurements of fluorescent depolarization and sedimentation constant. The evidence is that the first dye molecules taken up combine with an active group of the enzyme, and that the same group is involved in chymotrypsinogen, chymotrypsin and di-*iso*propylphosphofluoridate-chymotrypsin. The group concerned is therefore probably the enzyme-substrate-binding group, and it is of great interest that the group is free in the precursor molecule. Since the di-*iso*propylphosphofluoridate site is also essential for catalytic activity, this is associated with activation of the enzyme-substrate complex:

$$E + S \rightleftharpoons ES \rightarrow ES^* \rightarrow P$$

According to H. Neurath and W. J. Dreyer (Seattle), the conversion of the precursor chymotrypsinogen into the active enzyme chymotrypsin involves the hydrolysis of a peptide bond between arginine and an *iso*leucine residue, a similar process, but involving lysine, occurring in the trypsinogen-to-trypsin change.

In the living cell the enzymes are in contact with lipoidal membranes which may modify their activity, and this aspect was considered by M. J. Fraser, J. G. Kaplan and J. H. Schulman (Cambridge), who found negatively charged oil–water emulsions to adsorb positively charged catalase very strongly, the first eight monolayers of catalase being completely inactivated. A positively charged oil droplet, however, only adsorbed one monolayer of enzyme, which still retained some activity. Liberation of catalase from living cells has been found to give an eighteen-fold increase in activity in agreement with the emulsion findings. A paper by L. Robert and J. Polonovski (Paris) dealt with the liberation of xanthine oxidase from the fat droplets in milk by various methods. If enzyme activity can be modified by adsorption on membranes, then a new dimension is added to enzyme biochemistry within the cell.

Kinetics and Mechanism

The second half of the meeting was devoted to a consideration of "Kinetics and Mechanism". A paper by J. G. Kirkwood (Yale) advanced the view that, in addition to the usual dispersion and ion–dipole forces, the fluctuation of proton configuration on the protein part of an enzyme will lead to an attractive electrostatic force on a substrate molecule at its surface. If now in the process of forming the activated complex ($ES \rightarrow ES^*$) there is an increase in dipole, then there will be a lowering of ΔG^*, the free energy change of activation, that is, a catalytic action on the substrate. The discussion turned on how far this mechanism will predict the details of the activity/pH curves observed in practice—it accounts for the maximum observed in terms of only one arbitrary constant. A paper by K. J. Laidler (Washington,

D.C.) gave criteria for deciding the relative magnitudes of k_1, k_2 and k_3, and then tabulated ΔS^* (entropy of activation) in the various cases. Laidler stressed an interpretation of entropy changes in terms of water-release effects following polarity changes in the activation process.

E. L. Smith, B. J. Finkle and A. Stockell (Utah) discussed the hydrolytic action of purified papain. They found the Michaelis constant K_M ($K_M = k_2 + k_3/k_1$) and k_3 to vary with *p*H in a rather complex manner, *p*H optima depending upon temperature. The explanation given was that k_3 involves a sequence of steps,

$$E + S \rightleftharpoons (ES)_1 \rightarrow (ES)_2 \dashrightarrow (ES)_n \rightarrow P$$

and that the rate-determining step changes with temperature. The papain molecule contains an SH-group in the active site which may function by forming a thiol ester with the carbonyl group of the benzoyl arginine amide substrate. R. Lumry and E. L. Smith (Utah) prefer to consider the Michaelis equation simply as the general equation for the conservation of enzyme molecules, replacing K_M by β/α and k_3 by β, and then seeking correlations between α and β for the carboxypeptidase system for a range of variables, *p*H, solvent, etc. These authors stressed the need for a proper statistical treatment of the experimental results.

Four papers were presented on esterases. J. A. Cohen (Netherlands) has worked with acetyl cholinesterase and chymotrypsin and confirmed the studies of Shaffer and Summerson, using di-*iso*propylphosphofluoridate labelled with phosphorus-32. Reaction of the enzyme with this substance and subsequent hydrolysis yields phosphoserine; but it seems unlikely that serine is the initial site of attack, as *pK* evidence points to histidine as the active site. It may be that the di-*iso*propylphospho-groups migrate from an initial histidine site to serine, and B. J. Jandorf *et al.* (Maryland) presented evidence that ageing chymotrypsin–di-*iso*propylphosphofluoridate makes it more and more resistant to reactivation by nucleophilic agents. I. B. Wilson (Columbia), in his paper, pictured the active site of acetyl cholinesterase as an anionic site next to an esteratic site. While nucleophilic agents are normally used for removing the di-*iso*propylphospho-group from the esteratic site, he found that incorporation of a cationic group in the agent much increased its speed of action. Presumably the cationic group is adsorbed on the anionic (enzyme) site and helps the nucleophilic attack. Bergmann compared monoquaternary and diquaternary inhibitors with acetylcholinesterase and butyrylcholinesterase, and on this basis concluded that the former contains two anionic sites, the latter one, and ordinary liver esterase none.

Two papers were contributed on bacterial hydrogenase, a particulate enzyme. That by A. Couper, D. D. Eley and A. Hayward (Bristol and Nottingham) found the pH_2 conversion to be about five times faster than either $D_2 - H_2O$ or hydrogenation reactions. The true activation energy for the conversion was considered to be 10 k.cal., and a dehydrated film of bacteria was inactive but became active again on rehydration. A. I. Krasna and D. Rittenberg (Columbia) have found that, in the H_2/D_2O exchange, HD was the first species to appear in the gas phase, and they put forward a scheme for the conversion involving interaction of an enzyme hydride (*E*H) with water,

$$E\mathrm{H} + \mathrm{H_2O} \rightleftharpoons E\mathrm{OH} + \mathrm{H_2}$$

D. E. Koshland (Brookhaven) showed how isotope exchange may be used for excluding possible mechanisms of action of transferring enzymes, illustrating his methods with experiments on 5'-nucleotidase. In this case he was able to exclude an enzyme-phosphate complex as an intermediate in the hydrolysis of adenosine monophosphate. It would seem that both adenosine monophosphate and water must be adsorbed on the enzyme, and also that the adenosine serves to fix the orientation of active groups. R. K. Morton (Melbourne) has investigated the transferring activity of phosphatases with acceptors such as glucose, finding a competition between transferring and hydrolysis reactions, and from this concluding that there is a definite water-site in the enzyme.

G. Weber (Sheffield), in a theoretical paper, considered the transfer of energy between separated enzyme and substrate molecules, and from the protein part of an enzyme-substrate complex into the substrate molecule. He concludes that the latter is probably the way that the enzyme-substrate activated complex is formed. A theoretical paper by A. G. Ogston (Oxford) considered equilibria between enzyme, enzyme-substrate, enzyme-inhibitor and enzyme-substrate-inhibitor complexes and then discussed the free energy of activation ΔG^* for various limiting conditions. H. Gutfreund (Cambridge) outlined the results of applying the analysis of Gutfreund and F. J. W. Roughton to the initial non-stationary state of several hydrolytic enzymes, using a Gibson stopped-flow apparatus. This method leads to values of k_3 for formation of the enzyme-substrate complex, and a later paper by E. C. Slater (Amsterdam) showed how conventional kinetic data may also lead to values of k_1. Generally, k_3 is not simply a monomolecular decomposition, but is really $k_3{}'X$, where X is water or some other acceptor. By examining a given enzyme with a range of acceptors, a relation between apparent K_m and $V_{max.}$ ($= k_3 e$) is obtainable, which leads to values of $k_1 e$ and $k_3 e$, where e is the enzyme concentration.

Sir Rudolph Peters (Agricultural Research Council) compared the toxic properties of the natural fluorocitric acid with the synthetic material, containing unnatural isomers. The synthetic material is the more toxic with soluble aconitase, and less toxic with the mitochondrial preparation, which Sir Rudolph tentatively attributed to stereochemical differences between the preparations. Stereochemistry was a main consideration in the paper by B. Vennesland (Chicago). She has found that deuterated diphosphopyridine nucleotide is stereospecific when formed enzymatically, but not when formed by chemical reduction, showing that in the enzyme case the deuterium atoms must add on to the same side of the pyridine ring.

A further two papers dealt with enzymatic reductions by the reduced diphosphopyridine nucleotide. H. Theorell (Stockholm) examined the kinetics of reduction of aldehyde using liver alcohol dehydrogenase. He has established that the reduction goes through the binary complex of reduced diphosphopyridine nucleotide and liver alcohol dehydrogenase and has obtained values for the four rate-constants concerned. In the case of yeast alcohol dehydrogenase, it was mentioned that a ternary complex is involved. I. W. Sizer and A. Gierer have started from Westheimer's proof, using deuterium labelling, that in the transfer from reduced diphosphopyridine nucleotide to acetaldehyde the hydrogen atom goes to the carbon of the acetaldehyde. Arguing from the observed effects of *p*H on velocity and K_m, they

conclude that the second hydrogen atom is provided by the enzyme and not by an H_3O^+ ion from the solution.

The last three papers at the meeting were concerned with iron porphyrin systems. P. George and G. I. H. Hanania (Cambridge) discussed titration data for myoglobin derivatives, concluding that only one hæm-limited acid group is present. Q. H. Gibson (Sheffield) and F. J. W. Roughton (Cambridge) described work on evaluating velocity constants for the addition of four carbon monoxide molecules successively to the four iron atoms of the hæmoglobin molecule, and similar equilibrium constants with oxygen. The solutions for the equations were obtained using electronic computation. In the absence of differences in reactivity, the velocity constants should be in the ratios 4, 3, 2, 1, where 1 refers to addition of the fourth molecule. In fact, the first three constants do not vary much from this expectation, but the fourth constant is enhanced eighty-fold. Gibson described the experimental method used as an adaptation of the flash photolysis technique of Norrish and Porter. B. Chance (Pennsylvania) described work on determining pseudo first-order velocity constants for the steps of the cytochrome chain occurring within the cell,

$$O_2 \xrightarrow{k_1} \text{cyta}_3 \xrightarrow{k_2} \text{cyta} \xrightarrow{k_3} \text{cytc} \xrightarrow{k_4} \text{cytb} \rightarrow \text{fp} \rightarrow \text{DPN} \rightarrow \text{S}$$

where fp denotes flavoprotein. Using different wavelengths, it was possible to follow the concentrations of the individual components by spectrophotometric means, and Chance concludes that there is a graded series of reaction-rates from left to right along the chain. This fact must be taken into account in any proposed mechanisms for electron transport. Work was also described with nitrate as oxidizing agent and with photosynthetic systems.

It has only been possible to mention points from each paper in the above brief account, and reference to the lively discussions which followed the papers has had to be omitted. The Faraday Society is to be congratulated on its foresight in bringing together biochemists and physical chemists in what has proved to be one of the most stimulating discussions in recent years.

D. D. Eley

PULMONARY CIRCULATION AND RESPIRATORY FUNCTION

SYMPOSIUM IN DUNDEE

During September 15–16, Queen's College (University of St. Andrews), Dundee, organized a symposium on "Pulmonary Circulation and Respiratory Function", which was probably the first of its kind to be organized by a university institution. It was an interesting experiment because the papers read covered a wide range of subjects and the audience was drawn from a wide range of interests—namely, physicians and surgeons, pathologists, physiologists and applied physiologists. The interest taken in the symposium, to judge from the size and enthusiasm of the audience, was in large part due to the development during recent years of human cardio-respiratory studies all over the world. Much of the work discussed has not yet been adequately assessed from the point of view either of its scientific reliability, or its value in assisting in diagnosis.

Dr. de Burgh Daly (Institute of Animal Physiology, Cambridge) opened the programme with a paper on "Pulmonary Vasomotor Nerve Activity and its Possible Functional Significance". He pointed out that a great deal of careful experimental work on animals is needed to demonstrate the existence of changes in pulmonary vascular resistance due to the action of vasomotor nerves. Valid conclusions can only be reached from the results of animal experiments where factors such as the pulmonary ventilation and circulation can be controlled adequately. Without these precautions, passive changes in pulmonary flow, pressure and resistance may obscure the demonstration of active vasomotor changes. The demonstration of vasomotor responses, as Dr. Daly remarked, does not imply that they play any part in the responses of the intact animal. The conditions of these experiments are often highly artificial. In the human subject, the control of all the variables is so difficult a task that great care should be exercised in drawing any conclusions about the existence of an independent control of the pulmonary blood vessels. Even in animal experiments, the site of action of pulmonary vasomotor fibres is uncertain.

Dr. K. W. Donald (Department of Medicine, Birmingham) gave a paper on "The Pulmonary Circulation in Health and Disease", from which one gathered that the difficulties in designing appropriate experiments, to which Dr. Daly directed attention, must apply also to experiments on man. For example, though there is agreement that the pulmonary vascular resistance to blood flow is small, the effect of exercise on the resistance of the blood vessels is in dispute even in healthy subjects. Some workers consider that the resistance decreases during exercise, whereas others find that the pulmonary vascular bed acts passively in conducting blood. On this matter, there appears to be no agreement about the facts, so it is superfluous to consider whether any question of vasomotion is involved. Dr. Donald concluded that there is as yet no clear evidence of vasomotor activity in human lungs. The problems of physiology posed by disease are numerous and largely unsolved, and some of these were reviewed.

Prof. A. A. Liebow (Yale) stressed the importance of the bronchial arteries, the azygos and other systemic veins in the circulation. His experiments showed that it is possible to ligate the pulmonary arteries and veins and yet have a collateral circulation of oxygenated blood (the extent of which increased in the course of a few months) adequate to maintain life. He demonstrated these points with the aid of casts of the blood vessels and suggested that his experiments may have some application in the treatment of certain developmental abnormalities of the heart and large vessels, and in coronary occlusion. Sir Russell Brock (Guy's Hospital, London) directed attention to the studies which have been made on the physiology of the infundibulum of the right ventricle. Clinical observation both before and at operation in cases of Fallot's tetralogy, for example, make it essential that detailed information should be available about the conditions existing in the infundibulum before a successful operative result can reasonably be expected. He illustrated his thesis by reference to a number of clinical cases.

Prof. J. Gough (Welsh National School of Medicine, Cardiff) reported on the results of post-mortem examinations made in his Department on Welsh coal miners. There is a high incidence of deaths attributable to cor pulmonale and massive pneumoconiosis.

Prof. Gough described the vascular changes in the lungs in this disease and also indicated the value of studying the grosser pathology of the lungs with the aid of paper-mounted sections. Prof. P. R. Allison (Oxford) described his technique of studying left atrial pressures by puncture of the atrium with a needle inserted down a bronchoscope. His objective was an attempt to distinguish, on the basis of the pressure tracings he obtained, between cases of mitral stenosis and mitral incompetence. The results showed a sharp separation between the two groups, but this clear-cut result (as became apparent in the later discussion) may have been in part due to the selection of patients for a surgical opinion. The view was expressed by Dr. P. Wood (Institute of Cardiology, London) that the results might well have been less clear if an unselected series of cases of disease of the mitral valve was studied. Prof. A. C. Lendrum (Queen's College, Dundee) described his studies on the histology of the small arteries of the lungs in mitral stenosis. The deposition of fibrin in the vessel walls and the distortion of neighbouring nuclei resemble the changes seen in other diseases affecting different organs of the body. He attributed these changes in the lungs to a raised pressure in the pulmonary artery and illustrated them with most pleasing colour photomicrographs.

The discussion of all these papers delivered on the first day of the symposium did not serve to increase our knowledge of the mechanisms involved in the many and complicated effects discussed by the principal speakers, except, perhaps, the contribution of Dr. G. de J. Lee (St. Thomas's Hospital, London), who stated that appropriate measurements made during a Valsalva manœuvre indicate the existence of vasomotor phenomena in the lungs.

On the second day of the symposium, Dr. G. S. Dawes (Nuffield Institute, Oxford) described his experiments on the pulmonary function of new-born lambs, and the changes which take place during the first few hours of life. His observations show the importance of arterio-venous anastomoses (for example, patent ductus arteriosus) in the new-born lamb, which have the effect of tiding it over the period during which its lungs are becoming more distensible and more fully aerated. He emphasized the need for caution in applying his results to babies as we do not as yet know enough about the details of the circulation in the baby immediately after birth. Prof. W. Melville Arnott (Department of Medicine, Birmingham) described a selection of the numerous tests of lung function now available, and assessed their value as aids to diagnosis. Dr. D. V. Bates (St. Bartholomew's Hospital, London) reported on his experiments on gas diffusion studies as an aid to the assessment of lung function. He concluded that impaired alveolo-capillary diffusion is probably best revealed by a study of the 'diffusing capacity' of nitrous oxide. It is difficult to feel convinced about this, because one would imagine that diffusing capacity and ventilation of the alveoli are in some degree interdependent, and his method of calculating the diffusing capacity certainly does not take into account any ventilatory factor. Dr. L. G. C. E. Pugh (London) described the numerous devices (volume-cycled and pressure-cycled) now used for maintaining artificial ventilation for long periods. This communication had much topical interest in view of the present rise in incidence of poliomyelitis. Prof. I. Donald (Department of Midwifery, Glasgow) described a patient-cycled respirator which he has used successfully for assisted respiration in new-born babies. His physiological observations seemed to support some of those described by Dr. Dawes.

The discussion on the papers delivered on the second day of the symposium was noteworthy for two reasons. On one hand, it was clear that workers, conscious of the difficulty of human experimentation, were anxious to discover more about the physiological basis of the various tests of pulmonary function. On the other hand, a noteworthy contribution by Dr. R. Coope (Liverpool) reminded one that, in general, the tests of function which had been discussed had, as yet, only a limited application as aids to diagnosis. The symposium was a success both on the academic and the social sides. Queen's College went to great lengths to make the stay enjoyable, and it is no exaggeration to say that all the members of the symposium returned home refreshed in mind and body.

J. L. D'Silva

READING TECHNICAL COLLEGE

H.M. THE QUEEN MOTHER opened the new Technical College of the County Borough of Reading on October 26. This College was first foreshadowed by various Science and Art classes (under the South Kensington regulations); and these classes, which were already being maintained in 1882 by the local authority of Reading, themselves arose on foundations laid earlier by various individuals of vision and vigour. By 1892 a new University Extension College, associated with Christ Church, Oxford, had come into being in Reading and had incorporated the former Science and Art classes.

Eventually, the University College received its charter—to become the University of Reading of to-day—but additional evening classes for local students were continued without break for more than fifty years. Thus, by tradition—and no less by the close co-operation of to-day—important and enduring links have been forged between gown and town. During that same half-century, classes for younger students were also being developed at junior evening institutes by the local authority at Reading.

In 1946 the local authority—having already decided to provide a new technical college, and having acquired a building site—recovered from the University full responsibility for evening courses in engineering, building and commerce; and after a transitional session, the new Technical College organization came into being in September 1947. Its first task was to co-ordinate the existing senior and junior evening classes and to provide for their unified direction in the future. The University continued to provide accommodation (and is still so doing), but demand grew rapidly and the local authority found supplementary accommodation at some thirty additional places—thanks in particular to assistance from industry, schools, the Royal Berkshire Hospital, the public libraries, and various undertakings.

The second objective was the development of a service no longer restricted only to evening-work. Lack of accommodation for day-work was a serious difficulty.

The range of local need was wide. Reading is characterized not by any one predominating industry but by a wide spread of interest. Needs were also urgent, and the authority adopted a bold policy in an endeavour to meet them by compromise, adaptation and by co-operation willingly given on all sides.

Meanwhile, adequate new premises were planned in consultation with the appointed architects, Messrs. Lanchester and Lodge, of London. Work on the site began on October 2, 1950; the foundation stone was laid by the chairman of the Board of Governors (who at that time was also mayor of Reading) on October 3, 1952.

Transfer of the widely dispersed work of the College to the new buildings began at Easter 1955, when the top floor of the main block was handed over, and continued throughout the summer. This operation was completed early in September.

The College is at present organized in six departments: art and printing; building; commerce; domestic and women's trades subjects; engineering; science. During the first three weeks of the present session, 3,400 students enrolled and commenced their year's work: 1,700 for full-time and part-time day courses (most of them also attending additional evening classes) and an equal number for evening courses and classes only. In addition, more than 1,200 have enrolled at four associated evening institutes which are under the direct charge of the principal of the Technical College.

During the interim eight years pending completiou of the College buildings, the courses of study provided have been steadily augmented in range and progressively developed in level. Provision is now made for Higher National Certificate and corporate membership students in mechanical, electrical and production engineering, in building and in applied physics. Ordinary National Certificate courses are also provided in chemistry and commerce, and the former are developing towards Higher levels and the associateship of the Royal Institute of Chemistry. There is a wide range of crafts courses—many of them based on requirements for the full technological certificates of the City and Guilds of London Institute.

Courses for apprentices and journeymen in the printing industry have now been introduced and are meeting an important local need.

The Art Department, hitherto handicapped by lack of facilities, is now developing, and its policy is greatly strengthened by the interest of the University School of Fine Art.

The Commerce Department, offering courses leading to the intermediate and final examinations of many professional bodies, is also responsible for courses in modern foreign languages, retail distribution, grocery and further general education.

Domestic and women's trade subjects include various needlecrafts, catering, cookery, nursery nurses' work and pre-nursing. Much of this work is based on examinations; but provision is also made—at both the College and its associated institutes—for the housewife.

All departments also provide many short courses, including a number of postgraduate or refresher type which are arranged from time to time in consultation with industry, trade, commerce and various professional institutions.

The newly completed premises comprise a main block of four stories of total floor area about 100,000 sq. ft., and a workshops block of some 25,000 sq. ft. In order to provide, at this stage, the accommodation essential for the present known demands, emphasis has been placed on workshops, laboratories and drawing offices rather than on classrooms. There is no central hall or gymnasium; but a refectory, staff and students' common rooms, departmental libraries and staff studies have been included. There is also one large main lecture theatre. A master plan has been prepared by the architects for future development. The internal arrangements of the new buildings have been carefully planned in respect of both short-term and probable long-term requirements; they have been made as flexible as possible so that changes in the use of rooms and services can be made as simply and economically as possible. Invisible ceiling panel heating is provided, allowing uninterrupted wall space. Filament lighting is used generally, except for drawing offices and certain rooms in the Art and Printing Department, where fluorescent lighting is preferred.

In general planning, regard has been paid not only to the specific needs of each department but also to encourage the closest possible liaison between them, in the strong belief that all contribute their special elements within the total pattern of life to-day and also that each has much of lasting cultural value to share.

A plinth is provided in the main College forecourt for the display of pieces of sculpture, to be replaced every three years on the basis of a special competition arranged in co-operation with the University.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

THE annual report of the National Institute for Research in Dairying is a tribute to the remarkable variety of work which is being done to improve dairy products. Established in 1912 at the University of Reading, the Institute now has eight research departments. Three of these—the Departments of Dairy Husbandry, Feeding and Metabolism, and Physiology—deal, for the most part, with the problems, both immediate and fundamental, associated with the technique and scientific background of milk production. Included in the scope of these three Departments are questions of dairy farm management, the growing of crops suitable for feeding dairy cattle, the nutrition of dairy stock, and control of reproduction and lactation in cattle.

The other five departments—Bacteriology, Chemistry, Physics, Engineering and Nutrition—deal with the application of science both to farm production and to the more strictly industrial side of practical dairying. Problems, both *ad hoc* and basic, associated with distribution and manufacture of milk, and with the quality of milk products, are dealt with in these Departments, and they are inevitably concerned from time to time with investigations directly affecting the consumer of milk and of other dairy products.

Besides these eight Departments, there are Sections concerned with isotopes, statistics and psychology, as well as an experimental dairy.

Many investigations were begun or continued during the year. Further work on the rate of milk and milk-fat secretion, for example, has confirmed that the former decreases with increasing interval since the last milking more rapidly than the latter; the positive correlation between the milking-rate of an individual animal and the total lactation yield has been confirmed. It was also shown that the greatest number of new udder infections occurs in the first month of lactation, and in quarters which have not previously been infected the new infection-rate is found to be approximately 3 per cent in the

first month and 1 per cent for subsequent months; once a quarter has been infected and freed from infection, the probability of re-infection increases with the number of previous infections.

An examination of copper as a growth promoter in pigs indicated that either pure copper sulphate or a mineral mixture providing copper sulphate at about 0·1 per cent of the weight of the fattening meal gives an increased rate of growth in fattening pigs; even at this high level there is no suggestion that copper is toxic to fattening pigs. No benefit was obtained either in live-weight gain or efficiency of food utilization when the floors of styes were kept artificially warmed in winter.

Another inquiry revealed that, when measured in terms of the milk production of grazing cows, meadow fescue has consistently outyielded, in each of two seasons, both perennial ryegrass and cocksfoot. An investigation into the production of saliva by the cow showed that a milking cow, on a normal diet, in the course of a day probably produces more than ten gallons of saliva, a large proportion of which appears to be secreted while she is eating.

There are indications that the œstrogenic isoflavone, biochanin A, recently isolated from red clover, is present in other clovers, and also, probably to a lesser extent than in red clover, in timothy, Italian ryegrass, meadow fescue and cocksfoot. This substance is present (along with the related œstrogen genistein) in subterranean clover. It is, however, doubtful whether, in current agricultural practice in Britain, œstrogens in pasture plants have any significant effect on milk production or other physiological activities of livestock.

Claims made abroad that the addition of menadione to raw milk, or to the food of lactating cows, caused a marked improvement in keeping quality of milk could not be substantiated. In certain circumstances, menadione in the milk appeared to have a deleterious effect in cheesemaking. Its use as an additive to milk, in any event illegal, is also undesirable on technological grounds.

It was found that the gut contents of chicks about to hatch are sterile; but those kept without food after hatching develop a flora in a few hours. When recently hatched chicks are fed, a balanced gut flora is established within two days.

The whitening of milk which occurs at temperatures above 60° C. increases in magnitude with the acidity of the milk, and increases with additions of soluble proteins. On heating milk further, the rate of browning seems to depend only on the *p*H, the rate increasing with alkalinity. Milk sterilized in a plate heat-exchanger at 135° C. is whitened in colour and not browned.

The young calf was shown to be a poor converter of carotene to vitamin A. This seems to be the case for all very young animals examined, namely, calves, rats and chicks. Conversion efficiency increases with age.

A significant improvement in growth-rate and a reduction in the incidence and severity of scouring were frequently brought about in young calves by giving them an antibiotic supplement to the diet. The effect, however, appears to be much smaller where the calves are born and reared under good conditions of health and management.

An interesting finding was that the sense of smell seems to be less sensitive than the sense of taste in discriminating between flavours in dairy products, even when the observers concerned think otherwise.

SICKLE CELL GENE DISTRIBUTION

DR. H. LEHMANN has recently published two papers. The first is about the distribution of the sickle cell gene (*Eug. Rev.*, **46**, 3; 1954); the second deals with the Andaman Islands (*St. Bartholomew's Hospital J.*, 59, 99; 1955). From the observation of Herrick in 1910 of a case of chronic anæmia in a Negro student characterized by 'sickle'-shaped red blood cells, investigations have continually proceeded. It was first shown by Huck in 1923 that sickle cell anæmia behaved as a simple Mendelian character and that heterozygotes or carriers could be identified by the anaerobic incubation of blood, whereupon fresh normal blood would take on the sickle appearance. The chemical aspect was studied by Pauling (1950), who found that sickle cells contain a hæmaglobin which differs in its physical properties from normal adult hæmaglobin. Normal and sickle hæmaglobins could be separated by electrophoresis.

The incidence of the 'sicklæmic' gene was high in American Negroes (about 10 per cent); but other races did not seem to possess it.

In 1944 and 1945 Evans initiated a large-scale survey on the frequency of occurrence of sicklæmia in West Africa, and found a 20 per cent incidence in 561 Africans from Nigeria, the Cameroons, Gambia and the Gold Coast.

Further large-scale observations were made in West Africa by Findley and his collaborators, the results showing a frequency not very different from those found by Evans. Sickle cells were reported from East Africa in 1945 by H. C. Trowell and from Northern Rhodesia (12 per cent) in 1946 by Beet. Altmann in 1945 reported their absence in South African Negroes.

In 1949 Lehmann and Milne examined nearly 5,000 individuals of twenty-four different tribes in Uganda. In the Nilotic tribes the incidence of sicklæmia was strikingly homogeneous and varied from 21 to 28 per cent.

Foy and his colleagues (1954) surveyed the southern Sudanese and found that the Nilotics fall into two groups, one allied to the Uganda Nilotics and the other with Half Hamitic affinities.

The former group had a high sicklæmia incidence and the latter usually a low one (0·8–3·9 per cent).

In Bantu-speaking tribes sicklæmia varied in incidence, from 2 per cent in the Bairu tribe to 45 per cent in the Baamba—a secluded pigmoid tribe in the forest of the Mountains of the Moon.

The distribution of the sickle gene in Uganda seems to be connected with the invasion route of the pastoral Half Hamites, being lowest among the Bantu along that route and highest in the less-accessible swamps, jungles and mountain tops.

Allison (1954) put forward another explanation of the variable incidence of the sickling gene in the Bantu. It is assumed that the invaders occupied the healthiest and least malarious zones of the country. It is further assumed that the sickling gene has a selective advantage in malarious tracts, the *S* hæmaglobin being less desirable to the malaria parasite than the normal *A* hæmaglobin. It follows that the sickling gene will be most frequent in malarious surroundings. This theory is supported by the fact that the Half Hamitic tribes all live in the least malarious areas of Uganda and that adjacent Bantu tribes share both low malaria incidence and low sickling. But as Herman points out, the question is

complicated by the fact that a large admixture of physical Hamitic features in a Bantu tribe—presumably through intercrossing—is also connected with low sickling.

These researches led to the possibility that the distribution of the sickling and other blood genes (Rhesus, *ABO*, *MNS*, etc.) could as genetical markers throw light on to Haddon's theory of a Neolithic immigration from India into Africa.

Accordingly, in 1952 the Nuffield Foundation financed an expedition to South India, and extensive observations of the incidence of sickling were made by Dr. Lehmann in a number of communities.

The gene was found among the Veddoids, of the Nilgiris—primitive peoples who until recently were food gatherers with no knowledge of agriculture. The incidence in both Pancyans and Irulas was very high—more than 30 per cent—while in the Tamils, Telegus and Canarese the gene was not found.

Further reference is made to the prevalence of the sickling gene in the Veddoids of Arabia, and also in Greece, and to the distribution of other blood genes in relation to migratory movements of populations in past times.

Dr. Lehmann, in a brief summary, assigns high incidence of the sickling gene to three major factors: (1) the anthropological derivation of the population; (2) genetic regulation such as a high mutation-rate or balanced polymorphism (Neel, 1953); (3) a social situation which produces inbreeding.

The discussion is not on the whole well balanced, and no reference is made to a possible high coexistence between malaria and sickling in either South India, Arabia or Greece, though data are probably available. The fact that the highest sickling-rates are found in the socially lowest stratum of a population seems to be significant only in relation to gene introgression from other communities.

The second paper contains a general account of the Andaman Islanders. The results of the blood groupings did not point to any connexion between the Andamanese and the African peoples, but rather indicated relationship with the inhabitants of the Admiralty Islands and New Guinea. S. C. Harland

NATURAL INSECTICIDES IN WEST AFRICA

A SURVEY of the natural insecticides used by the peoples of West Africa has been made by Dr. F. R. Irvine (*Col. Plant and Animal Prod.*, **5**, No. 1).

The question of the toxicity to man of preparations used as insecticides is important where food crops are concerned; many of these African insecticides are also used for catching fish. The action of some of them is merely to stupefy the fish which, when afterwards eaten, are quite innocuous.

West African insecticides fall naturally into three groups, those containing (1) alkaloids; (2) rotenone or its close relatives; and (3) resins and oils. A few others are useful on account of an acid, tannin, or latex.

Of those containing alkaloids, the tobacco plants, *Nicotiana tabacum* and *N. rustica*, both probably long known as insecticides to West Africans, are in common commercial use. Species of *Datura*, especially *D. metel*, the active principle of which is hyoscine or scopolamine, are used on floors to destroy a bad pest—the jiggers or sand fleas which bore into the feet.

The powdered seeds of certain *Annona* have been reported from the tropics both as insecticides and as fish poisons. Water suspensions of the seeds of *A. reticulata* produced a high percentage of kill among the green bugs, *Lecanium*.

Another and more powerful alkaloid is found in the bark of the sassy bark or red water tree, *Erythrophloeum guineense*, which is used for destroying fish, game animals and rats, and as ingredient in arrow poison. The active compound is erythrophleine, which resembles digitalis in its action on the human body. In West Africa insecticidal use is made of the leaves, which are put with stored corn to keep insects away.

A leguminous shrub, *Sophora tomentosa*, contains in its seeds about 2·0 per cent of cytisine. This alkaloid has proved to be a relatively potent insecticide to adult *Aphis rumicis*, resembling nicotine in its physiological action.

The leaves of the Indian nim tree, *Melia azedarach*, have been successfully used on the Gold Coast for preventing infestation of cocoa beans by the insect *Ephestia*. Elsewhere they have been found to be repellent to locusts, and it is claimed that extracts can be effectively applied for the protection of fruit, vegetable and cereal crops.

Many plants contain rotenone or allied compounds. About two dozen species of *Tephrosia* are used as fish poisons in various parts of the world and some of them are used as insecticides. Among these, *T. vogelii* is of particular interest. Its pounded leaves and pods, thrown on water, stupefy fish in such numbers that its use had to be prohibited in certain areas. The fish so caught are quite edible. The seeds, too, have been proved by Wilbaux to be toxic to molluscs. (Here may be a substitute, probably innocuous to pets and song birds, for the material used in poison bait to combat the ubiquitous slug in British home gardens.) The leaves, when dried, are widely used by Africans for destroying human insect and other parasites, for example, head-lice and fleas. They are used by Europeans in Nyasaland against dog ticks and fleas and in Rhodesia and elsewhere against lice. *Tephrosia*, in at least five species, contains rotenone and other compounds in common with *Derris* and *Lonchocarpus*.

Another well-known fish poison is the leguminous shrub, *Mundulea sericea*, which kills rather than stupefies; it is risky to eat the fish afterwards. In Mysore, India, the pulverized bark of *M. sericea* has been used against various pests and the bark, roots and seeds as fish poison. East Africans declare the pounded bark to be sufficiently potent to kill man, and put into the water, they say, it drives away crocodiles. Though only small quantities of rotenone have been found in the air-dried bark, its toxicity is thought to be due to the presence of allied compounds. Certain East African tests showed it to be almost as lethal as *Derris* roots.

Allied to *Derris* is the leguminous genus *Lonchocarpus*. In South America this produces the well-known insecticide, cube, which, like derris, is a piscicide.

Some of the preparations which contain resins or oils are toxic by contact methods while others are effective as fumigants.

Certain *Dichapetalum* species are poisonous: their seeds to man, rats and parasites, their leaves to

stock. Their poisons are believed to be due to resins among other extractive matter. Particularly potent is *D. toxicarium*, though paradoxically enough its fruit pulp and that of certain other *Dichapetalum* species is edible. Its seeds are sold as rat poison in Freetown, Sierra Leone.

Obnoxious to insects is the bright yellow and partly water-soluble gum exuding from the cashew (*Anacardium occidentale*), and this adds to its value in bookbinding. The oil from the nutshells was proved in 1938 to be destructive to mosquito larvæ, and has been demonstrated to have distinctly toxic effects on certain grain weevils and moth larvæ.

Among fatty oils are the thick greenish oil from the seeds of the herb, *Gynandropsis pentaphylla*, used against human parasites (hair-lice) and as a piscicide, the bitter purgative oil from the seeds, and probably latex of the Mexican poppy, *Argemone mexicana*, which is used by certain pagan Nigerian tribes for warding off termite attack.

Conspicuous among aromatic insecticides are the essential oils of the Labiatæ. Of these the strongly scented *Hyptis spicigera*, *Leucas martinicensis* and *Ocimum americanum* are burned in rooms to get rid of mosquitoes, and layers of the *Hyptis* are placed below bundles of millet to keep away termites.

Although African growers have available a variety of materials of insecticidal value, Dr. Irvine does not suggest that these materials are necessarily alternatives to modern synthetic insecticides. In making a choice, many factors, such as local availability, persistence, ease of application and cost-effectiveness ratio, need to be taken into account. These plant products should be considered as useful supplements in the struggle against tropical pests. There is much scope for interesting research into the action of these vegetable pesticides, either alone or in combination, as well as into the chemistry of their active principles.

D. I. MENDELEIEFF AND THE PERIODIC SYSTEM

DMITRY IVANOVICH MENDELEIEFF (1834–1907), the discoverer of the periodic system of the elements and one of the greatest chemists of modern time, was also a very great Russian, and it is inevitable that in the U.S.S.R. much time and energy have been devoted to his life and work and to establishing his place in the history of science.

Mendeleieff was closely connected with education, research in pure and applied chemistry, mining and economic development of Russia. He was also one of the founders in 1868 of the Russian Chemical Society. The first Mendeleieff Congress met in December 1907, the year of his death. In its scope and purpose this congress was similar to a meeting of the British Association. Subsequent Mendeleieff Congresses took place in 1911, 1922, 1925, 1928, 1932 and 1934. The last of these in 1934 was the jubilee congress in celebration of the centenary of Mendeleieff's birth. For this congress the Academy of Sciences published "Selected Works of D. I. Mendeleieff"; but in 1937 it began publishing the complete works in fourteen volumes, of which a number has already appeared. Recent literature on Mendeleieff and on the periodic system in the U.S.S.R. is very extensive. Six books dealing with Mendeleieff and the periodic system reviewed here are of a particular interest to scientists and historians of science. One of these books is published in English, the remaining in Russian.

The first three are concerned with the life and work of Mendeleieff and the last three with the periodic system of the elements. The book written by Prof. B. G. Kuznetzov[1] is a first-class account of the life and work of M. V. Lomonosov (1711–65), N. I. Lobachevsky (1793–1856) and D. I. Mendeleieff (1834–1907). A more popular account is given by Pisarzhevsky, somewhat lengthy in the Russian text[2] and condensed in the English text[3]. The English edition is a nicely bound volume containing numerous well-produced illustrations, available at a very reasonable price.

Mendeleieff's greatest contribution to science, the periodic system, and its derivatives, has, since its discovery in 1869, played a very important part in the development of chemistry and physics. In 1944 the Russian All-Union Chemical Society, in conjunction with the Chemical Section of the Academy of Sciences, celebrated the seventy-fifth anniversary of the discovery of the Periodic Law (1869) and of the foundation of the Russian Chemical Society (1868). The papers read at these meetings were published as a volume in 1947[4]. The first part of this book (pp. 11–114) is devoted to the periodic law and contains five articles: (*a*) the periodic law of D. I. Mendeleieff and its creator, by the late A. A. Baikov; (*b*) the periodic system as the foundation of modern chemistry, by S. A. Shchukarev; (*c*) the periodic law of Mendeleieff and its significance in natural history, by the late A. E. Fersman; (*d*) the transformation of the elements and the periodic law, by V. G. Khlopin; and (*e*) the physical meaning of the periodic system, by A. F. Yoffe. The second part (pp. 115–265) is by V. V. Kozlov and A. I. Lazarev and deals with the history of the Russian Chemical Society. It includes biographical sketches of Russian chemists and contains numerous portraits and other illustrations. Unfortunately, it is not provided with an index.

A most spectacular achievement of the past decade has been the systematic study and classification of Mendeleieff's archives. A large number of 'scraps of paper' containing rough notes or simply scribbles, rough manuscripts of articles, printed copies with the author's correction and amplification notes, rough copies of letters and other materials—all this, when arranged and interpreted, provides a very valuable contribution to the history of the creation of the periodic system. The task of classifying and interpreting this material has been accomplished by Mendeleieff's daughter, the late M. D. Mendeleieff, T. S. Kudryavtzeva and B. M. Kedrov.

The first book dealing with this material was published in 1950[5]. In it only three documents are given and discussed: (1) the manuscript of the earliest form of the periodic table, scribbled over and altered; (2) the manuscript of the second form of the periodic table, the one which was sent to the printers in February 1869 and published in Russian and in French (March 1, 1869); (3) the original Russian text of Mendeleieff's article (dated July 1871), later translated into German and published in the *Annalen der Chemie und Pharmacie* (Supp. Vol. 8, pp. 133–229; 1872). The reproduction of these items is followed by a detailed account by B. M. Kedrov.

Plans have been made for the complete publication of the newly discovered material in three volumes: Vol. 1, covering the period 1869–71[6]; Vol. 2,

period 1860–68; Vol. 3, period 1872–1906. Of these, only Vol. 1 has so far appeared. It was published in 1953 and is a very substantial book of 866 pages, full of photo-reproductions of the original documents, explanatory tables and notes. It contains the three documents published in the previous book[5], but more fully annotated and analysed, and a mass of other documents—various sketches of the periodic table (including rough sketches of the spiral form), notes on various topics connected with the periodic system, manuscripts of articles, amended articles, letters, programmes of lectures, and so on. All these documents and their interpretation and annotation are valuable material for the historians of science.

A short review of this kind does not allow of detailed discussion; but the main process of Mendeleieff's creative activity with regard to the discovery of the periodic system may be summarized as follows. After lecturing on organic chemistry and chemical technology at the University of St. Petersburg from 1861, Mendeleieff at the age of thirty-three was appointed to the chair of inorganic or general chemistry in 1867. The preparation of this new course of lectures led him to write his text-book, "The Principles of Chemistry". He knew about some attempts at classification of the elements; but he had not seen the works of A. E. Béguyer de Chancourtois and J. A. R. Newlands. "When I began to write my text-book," Mendeleieff told Brauner, "I felt that I needed a system which would allow me to classify chemical elements. I had discovered that all existing systems were artificial and therefore useless for my purpose. I was anxious to establish a natural system. With this purpose in mind I wrote the signs of the elements on little slips of cardboard together with their atomic weights, and after this I began grouping them in different ways according to their similarities, but this did not satisfy me, until finally I placed the cards one after the other in order of the increasing weights of the element. Having placed in the table the first row: H = 1, Li = 7, Be = 11, C = 12, N = 14, O = 16, F = 19, I discovered that the following elements form a second row below the first row, beginning with lithium. Further I found, that in this new row—Na = 23, Mg = 24, Al = 27, Si = 28, P = 31, S = 32, Cl = 35·5—sodium repeats every property of lithium, and the same applies to all other elements. Similar repetition occurs in the third row, after a certain period, and continues in all rows" (5, p. 141). This may be a simplified account of his approach to the problem, because the 'scraps of paper' show a much more elaborate scheme of arrangements and groupings of the elements. It is interesting to note that the first two sketches of the periodic table were variants of the 'long chart', with vertical columns corresponding to periods, while later, struggling with the presence of two sets of similar elements in the long periods, Mendeleieff deliberately telescoped the 'long chart' into the 'short chart'. Subsequent history of the periodic table has shown, however, that the 'long chart' is in a better agreement with the modern view of atomic structure and is more suitable for certain branches of science.

S. I. Tomkieff

[1] Lomonosov, Lobachevsky, Mendeleieff. By B. G. Kuznetzov. [Russian text.] Pp. 332. (Moscow: Acad. Sci. U.S.S.R., 1945.) 22 r. [10s.] [Mendeleieff, pp. 189–332.]

[2] Dmitry Ivanovich Mendeleieff. By O. Pisarzhevsky. [Russian text.] Pp. 471. (Molodaya Gvardia, 1949.) 8 r. [3s. 6d.].

[3] Dmitry Ivanovich Mendeleyev. His life and work. By O. N. Pisarzhevsky. [English text.] Pp. 102. (Moscow: Foreign Languages Publishing House, 1954.) [2s.]

[4] Seventy-five Years of the Periodic Law of D. I. Mendeleieff and of the Russian Chemical Society. Edited by S. I. Volfkovich and V. S. Kiselev. [Russian text.] Pp. 265. (Moscow: Acad. Sci. U.S.S.R., 1947.) 16 r.

[5] D. I. Mendeleieff. New Materials relating to the History of the Discovery of the Periodic Law. Edited by N. A. Figurovsky. [Russian text.] Pp. 145. (Moscow: Acad. Sci. U.S.S.R., 1950.) 10 r. 35 k. [9s.].

[6] D. I. Mendeleieff. Scientific Archive. Edited by A. V. Topchiev. Vol. 1, Periodic Law. The Natural System of Elements. Manuscripts and Tables. 1869–1871. [Russian text.]. Pp. 866. (Moscow: Acad. Sci. U.S.S.R., 1953.) 42 r. 40 k. [36s.].

The price given in shillings refers to that payable in London.

APPARENT TRANSFORMATION OF COLLAGEN FIBRILS INTO 'ELASTIN'

By Prof. D. Burton, Dr. D. A. Hall, Dr. M. K. Keech, Dr. R. Reed, Miss H. Saxl, Prof. R. E. Tunbridge, O.B.E., and Miss M. J. Wood

University of Leeds

THE present communication deals with certain electron microscopical, histological and biochemical observations which appear to indicate a possible transformation of collagen fibrils into elastin-like material. This work forms part of a general study of the properties of connective tissue undertaken in the University of Leeds by the Nuffield Gerontological Unit (Dr. D. A. Hall, Miss H. Saxl) and the Departments of Medicine (Dr. M. K. Keech, Prof. R. E. Tunbridge) and Leather Industries (Prof. D. Burton, Dr. R. Reed, Miss M. J. Wood).

On the basis of electron-microscope[1] and biochemical studies[2], it has been suggested that the material common to all forms of elastic tissue is a complex system, consisting of two types of long-chain molecules, one a mucoprotein, the other a polypeptide chain, coated by a dense cement material—the so-called elastomucin. Morphologically, under the electron microscope, elastin-like fibrils are uniformly dense, ill-defined in shape, with no specific structural feature, in contradistinction to the fibrils of collagen, which have characteristic cross-striations (Fig. 1).

Electron-Microscope Studies

As a source of collagen fibrils for possible conversion to elastin, use has been made of preparations obtained by the modification of Neuman's method, described by Keech[3]. These preparations have been obtained from abdominal skin of patients of various ages, ranging from nine to eighty-two years. Although Neuman[4] claims that this material is the purest and least degraded form of collagen available, there is no evidence that the extraction procedure does not affect the intra-fibrillar constituents, especially polysaccharide. However, it would appear that the ground substance has been removed, and any effects observed arise from the collagen fibrils themselves, and not from any extraneous source. For com-

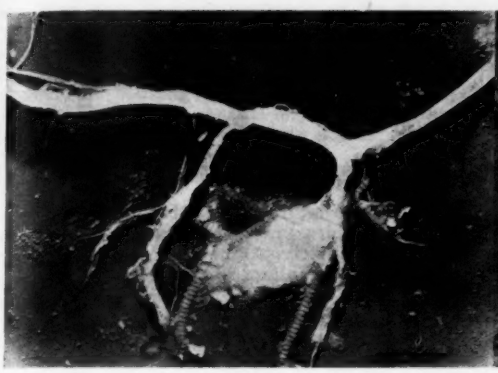

Fig. 1

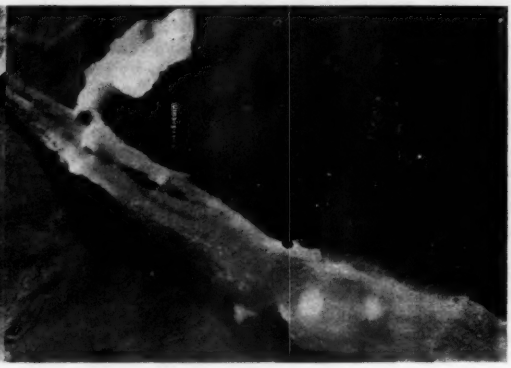

Fig. 2

Fig. 1. Control material from fresh whole dermis (7-year old child) showing striated collagen fibrils and an elastin-like fibre.
Fig. 2. Prepared dermal collagen, from a child aged 9 years, following incubation with borate buffer (*p*H 8·8) for 24 hr. at 37° C. Apparent transformation of bundle of collagen fibrils into 'elastin'

parison, fresh samples of skin were also examined. All preparations contained a small quantity of penicillin and streptomycin mixture, which successfully prevented bacterial contamination.

As part of a general survey of the effects of various reagents, for example, acids, alkalis and enzymes, on collagen, the substrates were treated with borate buffer solutions (*p*H 7–10·4) at 37° C. for varying periods of time. The electron microscope revealed a marked increase in amorphous material associated with degenerate collagen fibrils, and, by comparison with the controls, an increase in structures closely resembling the fibres of elastic tissue (Fig. 2). Moreover, the longer the time of treatment, the greater the number of such structures. In addition, collagen fibrils in various stages of modification were observed, ranging from the typical banded appearance to fragments of irregular shape, some showing a filamentous structure. This variety of structures indicated that certain collagen fibrils had degenerated, with the production of large quantities of amorphous material; the latter then apparently coated the many types of fibrils present, cementing them together and rendering the cross-striations and fibril outline indistinct. A further finding in collagen treated with alkali was the presence of a large number of dense, fine threads, about 150–250 A. in diameter and ranging in length from 2000 A. to about 4000 A. Their form varied, being either rod-like or curved with slightly tapered ends, both types occurring together (Fig. 3). These fine threads were randomly distributed on and between the collagen fibrils and were observed in all experiments in the range of *p*H values from 7 to 10·4, but only in the early stages of the treatment. At *p*H 9·8 and 10·4 the threads were longer and slightly thicker than those recorded at lower values, but after 2 hr. treatment at 37° C. they were no longer seen.

As the age of the sample increased, the effects observed, although still apparent, became more difficult to assess in view of the fact that the controls contained larger proportions of elastin-like structures.

Similar morphological appearance, that is, fibres resembling elastin in all stages of formation, were observed following the treatment of collagen with 1 per cent sodium metaperiodate in phthalate buffer of *p*H 5·0 at 37° C. for times ranging from 1 to 6 hr. (Fig. 4). It may be significant, however, that at this *p*H no threadlike structures were produced. Incubation with trypsin and chymotrypsin (each obtained from pig and ox) in phosphate buffer of *p*H value 7·3 at 37° C. for times ranging from 3 to 24 hr. also produced elastin-like structures.

Transformation into elastin-like structures was also observed, although the changes in the adult tissue

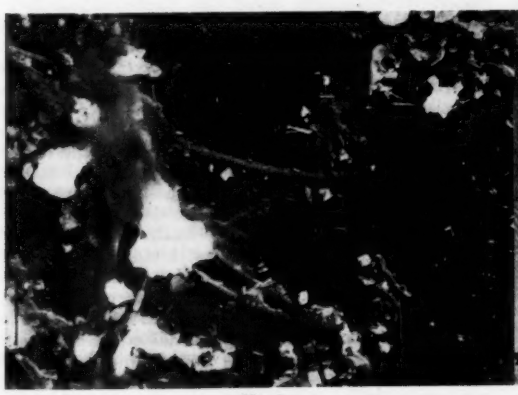

Fig. 3

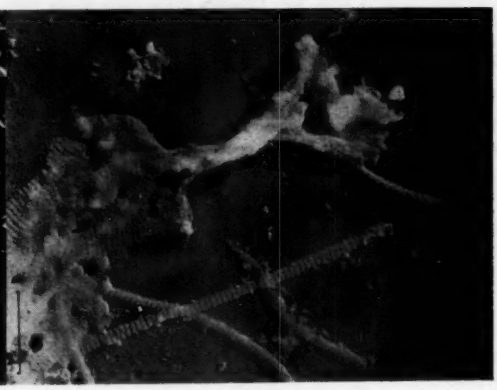

Fig. 4

Fig. 3. Same substrate and conditions as Fig. 2. Incubation time 14 hr., showing collagen, amorphous material and fine thread-like structures randomly distributed throughout the field. Fig. 4. Same substrate as Fig. 2 treated with 1 per cent sodium metaperiodate in buffer (*p*H 5·0) for 1½ hr. at 37° C. The degenerate collagen appears to be changed into 'elastin'

were less marked when fresh whole dermis was treated in borate buffer, *p*H 8·8 at 37° C.

It appears, therefore, that alkalis and certain pancreatic enzymes in alkaline solution, by acting on collagen at 37° C., may bring about profound changes. In the early stages of the reaction, small, threadlike structures are produced. Later, these can no longer be observed and many of the collagen fibrils appear to disintegrate with the formation of much amorphous material. Thus, there are strong morphological grounds for believing that collagen fibrils, under certain conditions—particularly those which are known to affect mucopolysaccharides—are capable of being transformed into structures closely resembling elastin tissue fibres. It is clear, however, from the electron micrographs, that the conversion of collagen into material resembling elastic tissue is not complete, that is, some collagen fibrils retain their characteristic cross-striated appearance.

Biochemical Studies

Morphological similarity alone, however, is no proof of strict identity and hence, parallel with the electron microscope work, biochemical studies were also made. Previous work on the amino-acid analyses of collagen and of chemically treated elastic tissue, which from the point of view of the electron microscope was apparently devoid of collagen fibrils, indicated marked differences in the relative amounts of certain amino-acids[5], a fact which in the past had caused us repeatedly to reject the possibility that elastin could be derived from collagen. Hydroxyproline constitutes 10 per cent of the amino-acid residues in collagen, but only 1·6 per cent of those in elastin. Hence the complete conversion of collagen into elastin should involve the removal of about 100 moles hydroxyproline for each 10^5 gm. of collagen. At the same time, other amino-acids which are also of low concentration in elastin would be expected to be lost.

In the initial stages of this work, since it was impracticable to examine the changes in all amino-acids, hydroxyproline was chosen for immediate study. Collagen preparations were obtained by methods identical to those used in the electron-microscope work; in addition, the treatment with alkaline buffer solutions was taken as the least complicated procedure for which biochemical confirmation of the structural findings might be obtained. After treatment with alkaline buffer, the reaction mixture was centrifuged and the residue separated from the supernatant liquid. The protein content of the supernatant was determined by the method of Lowry *et al.*[6]. Appropriate aliquots of the supernatant were hydrolysed under reflux with 6 *N* hydrochloric acid for 24 hr. and the hydroxyproline determined by Martin and Axelrod's[7] modification of the Neuman and Logan reaction[8]. The reducing sugars in this hydrolysate were estimated by the prussian blue method[9].

In certain cases the residues were re-extracted with further buffer, while in others replicate samples were incubated for varying periods.

Two samples from young subjects (7 and 3 years) were examined after 24 hr. extraction and the hydroxyproline content of the extracted protein found to be 33 and 24 per cent, respectively. After a further 40 hr. extraction, the percentage hydroxyproline in the protein from the latter sample was 18 per cent. Examination of a 15-year old subject demonstrated further the dependence of the hydroxyproline level on the time of extraction (Table 1).

Table 1

Time of extraction with buffer (hr.)	Protein extracted (per cent of dry weight)	Hydroxyproline content of extracted protein (per cent)
12	1·30	12·9
20	1·55	13·1
41	1·85	18·3
65	2·25	10·8
118	2·60	9·7

It would appear, therefore, that either the concentration of hydroxyproline of the extracted protein varies, or, more likely, a number of protein fractions are extracted simultaneously, and the varying hydroxyproline content of the whole is merely a function of their varying rate of extraction.

The degradation of the collagen accompanied by a variable retention of either hydroxyproline-rich or hydroxyproline-poor polypeptides has been borne out by further studies. In a number of other samples examined, the hydroxyproline content of the extract was very low indeed, remaining less than 6 per cent for the first 24 hr. extraction over an age-range from 5 months to 61 years, although the amount of protein extracted dropped progressively with age. The same variability was also observed in estimations of the liberated polysaccharide, for on those occasions when protein with high hydroxyproline content was extracted during the first 24 hr. the polysaccharide content was proportionally high.

Preliminary experiments with fresh tissue through which buffer was forced under pressure, followed by the fractional collection of the eluate, have produced results completely in conformity with the above observations. By this procedure, it has been possible to separate a protein fraction rich in hydroxyproline in a limited volume of eluate. The average hydroxyproline content of this material is 40 per cent, and although insufficient material has as yet been obtained for a complete analysis, it is noteworthy that arginine, another of the amino-acids which is at a markedly different concentration in collagen and elastin, is also present in the extracted protein in very high concentration.

Histological Studies

Samples of the skin tissue which had been extracted with alkaline buffer under pressure as above were examined histologically. Both frozen sections and teased preparations fixed in formol-saline were examined after staining with Hart's modification of Weigert's stain by normal and by polarized light.

Lamellar structures were observed in both the control and the treated material, but were more numerous and exhibited a wider variety of staining properties in the latter. Some of the lamellæ in the treated material were unstained, refractile and highly anisotropic and associated with dark blue-black masses of amorphous material. Other lamellæ in the treated material stained pale blue or pink and were anisotropic, whereas others stained like elastin and were not anisotropic. Further structures, histologically indistinguishable from elastin, in the form of wavy, intensely blue-black fibrils were observed. Highly anisotropic lamellar structures of this type have been described by A. J. Cruise (personal communication) in skins of various animals and in human achilles tendon. He also reported that they can be split up into fine fibrils by crushing. Occasionally non-staining anisotropic lamellar structures have been observed so arranged that it might be inferred that

they have been formed as a result of the fusion of collagen fibrils. Since such a wide range of staining properties and degrees of anisotropy exist, it is possible that this gradation reflects the production of material staining like elastin from collagen. Whether such is the case or not, the fact remains that material staining like elastin is produced from collagen under conditions known to be associated with comparable biochemical changes.

Discussion

It appears, therefore, that under conditions which lead to the transformation of collagen fibrils into structures closely resembling those found in naturally occurring elastic tissue, protein fractions rich in hydroxyproline and arginine are liberated from the collagen. Such changes in the distribution of amino-acids in the system are those to be expected from a comparison of the chemical composition of both collagen and elastin, and by themselves support the view that the transformation product is indeed elastic tissue. It is clear, however, that if elastin is derived from collagen fibrils, the transformation must involve a deep-seated and complex breakdown of some of the polypeptide chains of collagen, particularly since protein fragments low in hydroxyproline and arginine content are released simultaneously.

This generalized breakdown of collagen followed by recombination of certain of the products to form 'elastin' is consistent with the existence of 'elastins' of varying composition, since the degree of degradation, and the composition of the resultant amorphous elastomucin, can presumably vary over quite wide limits without affecting the ill-defined morphology of the elastin fibre. This possibly explains the varying composition of 'young light' and 'old heavy' elastins (Lansing)[10], and probably accounts for the observation that a third component, apparently intermediate in properties between elastin and collagen, exists in aorta tissue. From its amino-acid content, Hall has suggested that this component resembles collagen[5]. The possibility that collagen fibrils actually form an integral part of certain natural elastins has been suggested by Banga[11], and certain of our preliminary observations support this view.

Elastin supposedly freed from collagen by prior treatment with acetic acid[5] was examined under the electron microscope and found devoid of visible collagen. Following incubation with collagenase at 37° C., the presence of collagen-like fibrils was revealed which were ultimately completely digested by the enzyme.

It would appear from the fact that the transformations occur equally in the case of collagen completely freed from ground substance, that is, prepared by the modification of Neuman's method described by Keech[3], and in fresh tissue, that the transformation is essentially a property of the collagen fibrils themselves and is not dependent on the presence of ground substance or matrix. This does not preclude the participation of the ground substance in any *in vivo* process.

As might be expected, since the transformation conditions are those which are likely to affect the mucoprotein links in collagen, the release of protein fractions rich in hydroxyproline is invariably accompanied by the release of carbohydrate material with a high content of reducing sugars. This not only confirms the importance of polysaccharides in helping to determine the stability of collagen fibrils, but also points to a possible close association of hydroxyproline and polysaccharide in collagen. In any event, the present studies indicate that hydroxyproline residues may also be of particular importance in aiding the cohesion of collagen fibrils, in agreement with the recent work of Gustavson[12], who has shown that the hydroxyproline content of various forms of collagen is an index to their thermal stability.

In 1894, Unna[13] suggested that there exists a family of connective tissue components with differing tinctorial characteristics showing a full spectrum of properties between collagen and elastin. These substances, which were observed in pathological tissue, he named collacin, collastin and elacin, and claimed they were degradation products of collagen on one hand and elastin on the other. There has been much doubt as to the identity of these materials, especially after chemical analyses of so-called typical examples of collagen and elastin had shown how markedly these two differed in amino-acid composition[14]. However, no one has as yet been able to describe any cell to which definite elastoblastic activity could be ascribed, and recently the morphogenetical dependence of elastin on collagen has been emphasized. For example, Robb-Smith[15] says: "In the embryo and in healing wounds elastica appears later than the collagen fibrils, and indeed it would appear that collagen is a prerequisite for its formation".

If some process similar to that induced artificially by alkali described above is operative *in vivo*, many of the anomalous observations of embryology, pathology and histology could be explained. If collagen can be transformed into elastin, there is no need to postulate a separate elastoblast. The presence of elastin in smaller or greater amounts in most sites containing collagen is explained, and degenerate diseased tissues which contain histologically elastin-like structures assume their proper position in the scheme of connective tissue components, since it has been shown that the elastin-like masses in senile elastosis are really degenerated collagen with excess of amorphous material[16].

On the basis of X-ray diffraction studies, Astbury has tentatively placed elastin in the collagen group of fibrous proteins[17]. These observations appear to support this contention.

Full details of the apparent transformation of collagen fibrils will be reported later.

The pancreatic fractions and collagenase (*Cl. welchii*) were kindly supplied by Dr. C. G. Pope, of the Wellcome Research Laboratory, and the collagenase (*Cl. histolyticum*) by Dr. J. D. MacLennon.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Isocitritase in *Escherichia coli*

Isocitritase, the enzyme which splits isocitric acid to succinate and glyoxylate, has been found in *Pseudomonas aeruginosa*[1,2] and *Penicillium chrysogenum*[3]. This communication describes this enzyme in *Escherichia coli*.

E. coli cells (strain *E*26) were grown for 24 hr. with aeration on a medium consisting of 1·5 per cent sodium acetate, 0·8 per cent potassium phosphate, 0·4 per cent ammonium sulphate, 10 per cent (by volume) tap water for inorganic ions and 0·1 per cent yeast extract at *p*H of 7·0. Initial experiments with extracts of these cells treated twice with 'Dowex-1' showed that citrate is metabolized to equivalent concentrations of succinate and glyoxylate without the production of carbon dioxide (Table 1). The same extracts, when fractionated to remove aconitase after the procedure of Smith and Gunsalus[1], were found no longer to produce these compounds from citrate or *cis*-aconitate but were active on isocitrate. The stoichiometry of the isocitritase reaction is shown in Table 2. Partially purified preparations required a divalent ion as well as cysteine. Isocitritase does not require coenzyme A or adenosine triphosphate, as indicated by the fact that treatment with 'Dowex' and dialysis which completely removes coenzyme A, and adenosine triphosphate does not alter its activity.

Table 1

Glyoxylate and succinate formation (μmoles) from citrate by cell-free extracts of *Escherichia coli*. Total volume of reactants, 3·0 ml. Each vessel contained the amount of citrate indicated, 1 ml. of an *E. coli* extract treated twice with 'Dowex', 5 μmoles of magnesium chloride, 10 μmoles of cysteine, 0·15 ml. of 1 *M* phosphate buffer *p*H 7·4 and 0·3 ml. of sulphuric acid in side-arm. Conditions completely anaerobic. Temperature, 33° C. Time of incubation, 60 min.

Exp. No.	Citrate		Δ Citrate	Products		
	Initial	Final		Succinate	Glyoxylate	Carbon dioxide
1	19·02	11·05	7·97	7·19	7·85	<1
2	19·02	9·99	9·03	8·11	10·64	<1

Table 2

Glyoxylate and succinate formation (μmoles) from isocitrate. Total volume of reactants, 3·0 ml. Each flask contained the amounts of substrate indicated: 20 μmoles of cysteine, 10 μmoles of magnesium chloride, 10 μmoles of phosphate buffer, *p*H 7·4 and 0·8 ml. of enzyme. Time of incubation, 40 min. Temperature, 33° C.

Substrate	Concentration		Δ Substrate	Products	
	Initial	Final		Glyoxylate	Succinate
Isocitrate	11·5	5·7	5·8	6·0	4·7
cis-Aconitate	20·0			0	0
Citrate	20·0			0	0

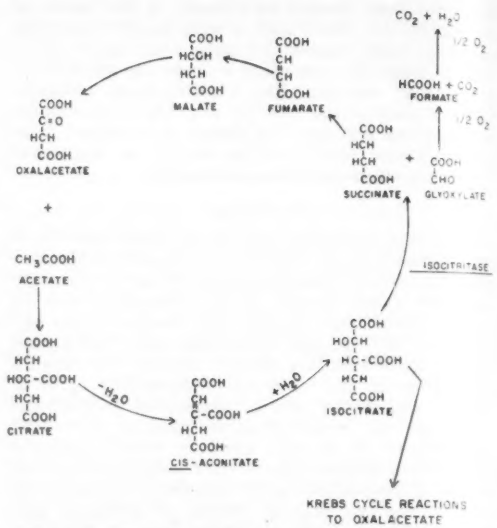

Fig. 1. An alternative cyclic pathway of acetic acid oxidation

Succinate was determined by the conventional succinoxidase procedure and glyoxylate by the method of Friedemann and Haugen[4]. To establish definitely the identity of glyoxylate, a large-scale experiment was performed and the glyoxylate isolated as its 2,4-dinitrophenylhydrazone. The material upon recrystallization from a mixture of ethyl acetate and petroleum ether had a melting point between 189° and 191° C., as did the hydrazone of authentic glyoxylate.

Radioactive citrate, prepared with the condensing enzymes and incubated with isocitritase plus aconitase, cleaved the C_6-acid asymmetrically to yield unlabelled glyoxylate and radioactive succinate (Table 3).

The dissimilation of the C_6-tricarboxylic acid to succinate and glyoxylate makes an interesting list of important intermediates from the tricarboxylic acid cycle. In this case, succinate can continue through the cycle so long as glyoxylate is available for amino-acid synthesis. According to Campbell[5], the energy produced during one turn of the cycle should be only 40 per cent of that obtained from the conventional scheme. It is also conceivable, however, that the glyoxylate is oxidized to carbon dioxide and water, in which case acetate would be oxidized to completion via a cyclic mechanism depicted in Fig. 1.

The overall picture of this series of reactions is one in which one mole of acetyl-coenzyme A enters the cycle and is oxidized to carbon dioxide and water via glyoxylate, while oxalacetate is first converted to succinate via isocitrate and is then regenerated

Table 3

Formation of radioactive succinate from labelled citrate. Total volume of reactants, 3·0 ml. Each vessel contained 1 ml. of enzyme (aconitase plus isocitritase), 10 μmoles of cysteine, 0·15 ml. of 1 *M* phosphate buffer, *p*H 7·4, 0·3 ml. sulphuric acid in side-arm and 18·52 μmoles of citrate containing 639 counts/min./μmole

Citrate			Δ Citrate (μmole)	Succinate		Glyoxylate	
Initial (μmole)	Final (μmole)	Initial specific activity (counts/min./μmole)		Conc. (μmole)	Specific activity (counts/min./μmole)	Conc. (μmole)	Specific activity (counts/min./μmole)
18·52	11·57	639	6·65	5·53	702	7·32	Inactive

by the oxidation of succinate via fumarate and malate. It is interesting to note that some evidence already exists in the literature to support this hypothetical scheme of acetate oxidation. Campbell[6], studying the mechanism of allantoin degradation by an unidentified *Pseudomonas*, presented convincing evidence that allantoin is broken down in the following manner: allantoin → allantoic acid → glyoxylic acid + urea; glyoxylic acid → formate + carbon dioxide; formate → carbon dioxide + water. Since various species of the genus *Pseudomonas* contain the enzyme isocitritase and are known to contain all the other enzymes necessary for the conversion of acetate and oxalacetate to isocitrate via fumarate and malate, it is not beyond reason to assume that acetate may indeed be oxidized to carbon dioxide and water by this alternate series of cyclic reactions. Investigations are now being conducted in our laboratories to determine whether *E. coli* might oxidize acetic acid in this manner.

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Fractionation of the Deoxyribonucleic Acid of *T2r* Bacteriophage

A number of investigations indicate that the deoxyribonucleic acid (DNA) of *T2* bacteriophage plays a major part during the infection of its bacterial host and in the maintenance of genetic continuity during the multiplication process[1]. Recent work[2] has demonstrated the inhomogeneity of deoxyribonucleic acid from various sources with respect to the content of the purine and pyrimidine bases and the ease of dissociation from complexes with basic proteins. This communication describes results obtained by applying a chromatographic fractionation procedure based on the latter property to the deoxyribonucleic acid of *T2r* bacteriophage.

Large-scale lysates of the *T2r* strain were obtained by growth in aerated bottles and the bacteriophage purified by the method of Herriott and Barlow[3]. Deoxyribonucleic acid was prepared (private communication from A. D. Hershey) from the purified bacteriophage after precipitation in 95 per cent alcohol by resuspending in 0·2 *M* sodium chloride, agitating with chloroform in a blender and centrifuging to remove denatured protein. After three such treatments with chloroform, the process was repeated with a 9 : 1 chloroform – octanol mixture until no further denatured protein precipitate was formed. The deoxyribonucleic acid was then precipitated in 95 per cent alcohol, washed in 75 per cent alcohol and stored in 75 per cent alcohol at 4° C. until required.

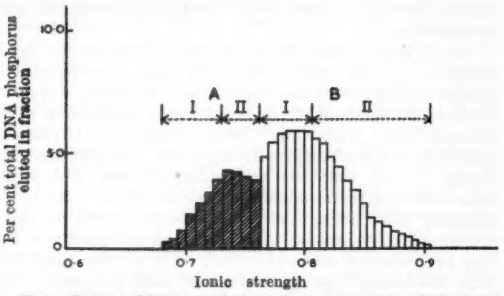

Fig. 1. Elution of *T2r* bacteriophage deoxyribonucleic acid from a column of cellulose–histone by a concentration gradient of sodium chloride at *p*H 6·8. The percentage of total deoxyribonucleic acid phosphorus eluted in a fraction is plotted against the ionic strength of the fraction

Calf thymus nucleohistone prepared by the water-extraction procedure of Crampton *et al.*[4] was extracted with 0·2 *N* hydrochloric acid and the extracted histones fractionated on columns of phosphorylated cellulose prepared by the method of Hoffpauir and Guthrie[5]. Elution by a gradient of *p*H and sodium chloride between *p*H 9·0 and *p*H 13·0 and 0·2 *M* to 1·0 *M* respectively was used, and the fraction coming from the column between *p*H 10·1 and *p*H 10·4 was attached to cellulose after denaturing by heating to 100° C. for 10 min. The diazotization method originally used by Campbell *et al.*[6] to couple albumin to cellulose was used here to couple the denatured histone to cellulose to form a material to which deoxyribonucleic acids are adsorbed at low salt concentrations and from which they can be eluted at high salt concentrations.

5–10 mgm. of the bacteriophage deoxyribonucleic acid were slowly eluted from a column of the cellulose–histone complex, 70 cm. long and 2 cm. in diameter, over a period of 40 hr. by a solution of continuously increasing concentration of sodium chloride buffered at *p*H 6·8. The deoxyribonucleic acid was eluted, as shown in Fig. 1, where it is evident that there are two distinct fractions *A* and *B*; this was confirmed by repeating the elution on the pooled fractions *A* and *B* separately. Deoxyribonucleic acid prepared from *T2r* bacteriophage after osmotic shock[7] gave the same elution diagram, demonstrating that the method of preparation was not responsible for the bimodality observed.

That *A* and *B* are two distinct deoxyribonucleic acid species was finally confirmed by measurements of the contents of purine and pyrimidine bases which were made on the pooled fractions *A* and *B*, and also on the first and second halves of *A* (*A*I and *A*II), and on the first and second halves of *B* (*B*I and *B*II) to be eluted from the column. The contents of purine and pyrimidine bases in the fractions were measured after hydrolysis with formic acid[8] by two-dimensional chromatography (ref. 1, Hershey, Dixon and Chase). The results of base analysis on fractions from three separate fractionations are shown in Table 1, expressed briefly as the ratio of the content of adenine and thymine to the content of guanine and 5-hydroxy-

Table 1. Base Ratios of *T2r* Deoxyribonucleic Acid Fractions

	Unfractionated *T2r* DNA	Fractions					
		A	*A*I	*A*II	*B*	*B*I	*B*II
$\frac{\text{Adenine + thymine}}{\text{Guanine + 5-hydroxymethylcytosine}}$	2·06	1·89	1·88	1·92	2·14	2·15	2·21

methylcytosine, each value being the mean of six estimations.

It appears, then, that the deoxyribonucleic acid prepared by the above methods from *T2r* bacteriophage contains two fractions, one containing approximately 30 per cent of the total deoxyribonucleic acid phosphorus, with the ratio adenine + thymine/guanine + 5-hydroxymethylcytosine approximately equal to 1·9, and the remaining 70 per cent with that ratio approximately equal to 2·15. As it is unlikely that these distinct fractions would be produced by degradation of a larger single molecule by the preparative methods used, this means that the *T2r* bacteriophage particle contains at least two different species of deoxyribonucleic acid molecule which differ in their ease of dissociation from basic protein and their content of purine and pyrimidine bases.

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Crystalline Inhibitors of Trypsin from Potato

Recently, Sohonie and Ambe[1] have reported the preparation of crystalline inhibitors of trypsin from field-bean and double-bean. Unlike these inhibitors, which are comparatively stable to heat treatment, the acid extracts of potato (*Solanum tuberosum*) have been found to contain a thermolabile inhibitor[2]. We have now examined the possibility of preparing this inhibitor in quantity in a crystalline form.

A method similar to that described for the crystallization of field-bean and double-bean inhibitors[1] was successfully employed, with the difference that all the operations were carried out in the cold to minimize any loss of activity in the course of preparation. The crude inhibitor, precipitated by ammonium sulphate, yielded two fractions. One was extracted by 2·5 per cent trichloroacetic acid, while the other, insoluble in trichloroacetic acid, was removed from the residue, in 1 per cent saline. Further purification, lyophilization and crystallization were carried out essentially as described in the previous communication.

Both fractions are dirty white in colour, soluble in water and twice as potent as the inhibitors from field-bean and double-bean. These were also found to have a powerful anticoagulant action on citrated human plasma.

Heat treatment resulted in 80–90 per cent destruction of the activity. Both components gave characteristic protein reactions and were found to differ widely in lysine, histidine and methionine contents.

A detailed report of the study of the different physico-chemical properties, etc., of the potato inhibitor fractions will be published in the *Journal of Scientific and Industrial Research* (India). We are grateful to the Council of Scientific and Industrial Research (India) for financing this work and for a personal grant to one of us (K. S. A.).

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Interference between Variants of Pseudorabies Virus demonstrable in Tissue Culture

The results of a series of investigations dealing with the cytopathogenic activity of pseudorabies virus have recently been reported from this Institute[1]. In these studies a strain of pseudorabies virus was serially transferred in tissue suspensions derived from chick embryos, and these served as a source of virus for the experiments. Destructive effects of the virus on tissue cultures made from fragments of embryonic chicken heart were recorded, and the cytopathogenic titre of virus material was used as a measure of its activity. Our present experiments have demonstrated that the virus became modified in its cytopathogenic activity for chicken cells by passages carried out in tissue suspensions of mouse embryo. The change in cytopathogenicity set in after four or five serial transfers of the virus in this tissue suspension. The characters of virus materials serially passed in suspensions of chicken and mouse embryonic tissue respectively are given in Table 1.

As is seen, the most striking feature of mouse (*MEC*) virus is its low cytopathogenic effect on chicken cells. It should be noted that the change in properties of virus cultivated in mouse tissue was not permanent. When *MEC* virus was serially transferred in embryonic chicken tissue, its destructive effect for chicken cells gradually increased, and it had regained its original properties within three to five passages.

The low cytopathogenic effect of *MEC* virus on chicken explants suggests a potential ability of this

Table 1. Characters of Pseudorabies Virus Propagated in Tissue Suspension either of Chick Embryo (*CEC* Virus) or Mouse Embryo (*MEC*) Virus

Mode of titration of virus	Virus material			
	CEC		*MEC*	
	No. of materials tested	Geom. mean of titres	No. of materials tested	Geom. mean of titres
Cytopathogenic effect of virus on chicken cells	45	$10^{-6\cdot4}$	46	$10^{-1\cdot13}$
Cytopathogenic effect of virus on mouse cells	4	$10^{-6\cdot1}$	11	$10^{-1\cdot6}$
In young chickens intracerebrally	1	$10^{-6\cdot3}$ ($LD50$)	1	10^{-4} ($LD50$)
In mice intracerebrally	20	$10^{-6\cdot3}$ ($LD50$)	34	$10^{-1\cdot9}$ ($LD50$)

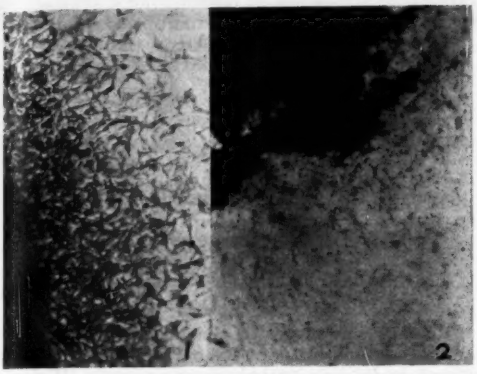

Fig. 1. Explant of embryonic chicken heart previously exposed to 10^{-4} dilution of *MEC* virus material and cultivated for 72 hr. with *CEC* virus of 10^{-6} dilution. × 75

Fig. 2. Control explant cultivated for 72 hr. in the presence of 10^{-7} dilution of *CEC* virus. × 75. Note complete destruction of tissue culture

variant to interfere with virus material highly destructive for chicken cells (*CEC*). To test this possibility, fragments from embryonic chicken heart were added to a nutrient medium containing *MEC* virus in a dilution of 10^{-3}–10^{-4} and kept at 37° for 24 hr. Simultaneously, control tissue material was also incubated. Next day, sets of tissue explants were made in chicken plasma from both tubes, infected with a serial dilution of *CEC* virus and re-incubated for three days. As a mean value of eleven experiments, the cytopathogenic titre for cultures made from material treated previously with *MEC* virus was $10^{-3 \cdot 7}$, whereas that of the control was $10^{-7 \cdot 3}$.

Our observation is in many respects similar to that of Sabin[2], who found that after exposure to a non-cytopathogenic variant of poliomyelitis virus, epithelial cells derived from monkey kidney had acquired a limited resistance to the destructive effect of unmodified virus.

Full details of these observations will be published in the *Acta Microbiologica Hungarica*.

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Elimination of Adrenaline and Noradrenaline from the Circulating Blood

The mode, the loci, and the extent of the inactivation of the sympathetic hormones are only partly known. The liver has been considered of prime importance. A minor fraction of injected catechols appears in the urine. Recently, the rather generally occurring enzyme amine-oxidase has been extensively studied as the agent responsible for a more general, 'peripheral' elimination.

The method described in this preliminary communication has made possible *in vivo* studies to determine which tissues are capable of eliminating adrenaline and noradrenaline from the blood stream. Furthermore, the extent of this removal over a certain length of time has been evaluated fairly closely. Briefly, the approach was as follows. Cats were used in which any release of endogenous catechol was cut down to a minimum by transection of the cervical spinal cord and extirpation of the adrenal glands. Adrenaline or noradrenaline was administered into the circulating blood at a constant speed, either intra-arterially to the tissue area studied, or intravenously into the brachial vein. The level of contraction of the chronically denervated nictitating membrane was used as an indicator of the concentration of catechols in the systemic circulation. The minimal effective dosage of adrenaline and noradrenaline on the denervated nictitating membrane was explored by intravenous administration at a constant rate. The actual experiment was started with an intra-arterial infusion of the drugs to the tissue area studied. After some minutes, when a steady state had been established, the intra-arterial infusion was momentarily shifted to an intravenous one, without any change of the actual amount administered. From a theoretical point of view, any of three alternatives might show up:

(1) The tissue area studied might not be capable of any elimination of adrenaline or noradrenaline. In this case the amounts infused intra-arterially must reappear quantitatively at the venous side after the steady state is established. A momentary shift of the route of administration of catechols to an intravenous route would therefore not influence the concentration of catechols in the systemic circulation, and thus leave the nictitating membrane unaffected.

(2) If a fraction of the intra-arterially infused catechols was locally eliminated, less would reappear in the venous outflow than entered the area on the arterial side. A shift of the infusion to an intravenous route would then reveal the extent of the local catechol loss by a corresponding increase of the contraction of the nictitating membrane.

(3) A third possibility, recently seriously claimed (see, for example, Granaat[1]), postulates that certain tissues actively secrete catechols when influenced by the sympathetic hormones, and that actually more catechols leave the area than ever entered it.

In most of the experiments of the present series, adrenaline or noradrenaline was infused through the cannulated inferior mesenteric artery into the lower abdominal aorta of the eviscerated animal, and thus primarily directed to an area comprised of skeletal muscle and skin. The results were quite uniform. The shifting of the infusion from an intra-arterial to an intravenous route, without any change of the actual dosage, was followed by a rapid and pronounced contraction of the denervated nictitating membrane, indicating a corresponding increase in the concentration of catechols in the systemic circulation. The extent of the loss of catechols following the intra-arterial administration could then be measured by applying the ordinary procedures of a biological assay. From a quantitative point of view, the elimination of catechols in the tissue area referred to was quite impressive. In the cat the upper limit of catechol release from the adrenals is roughly 5 μgm./kgm./min. However, even during extreme physiological stress, such as asphyxia, the amounts released seldom exceed 2–3 μgm./kgm./min. (ref. 2).

In the present series, the tissue area primarily reached by the intra-arterial infusion into the lower abdominal aorta approximately equals one-third of the animal. From this, it appears that the skeletal muscle – skin area under examination during a single passage of blood eliminates up to 90 per cent of the amounts of catechols infused. This holds true so long as the dosage was kept within the physiological range of adrenal discharge. When higher concentrations of adrenaline or noradrenaline were given, a proportionally larger fraction of the amounts infused intra-arterially reached the venous side, indicating that the rate of local elimination of catechol was no longer able to cope with the increased rate of intra-arterial infusion (Fig. 1).

The extensive loss of the sympathetic hormones in this rather non-specific tissue area can only in part be attributed to amine-oxidase, since all the basic findings were still present after the administration of specific inhibitors of this enzyme. Neither was it possible to find a clear-cut distinction as to the affinity of adrenaline and noradrenaline to the unknown mechanism responsible for the observed elimination of these substances. However, noradrenaline was not eliminated more rapidly than adrenaline; rather, the contrary appeared to be the case.

Additional experiments were carried out on other tissue areas, such as the spleen, the kidneys and the intestines. The basic findings did not vary from those already mentioned, although quantitative differences require further study. In addition, the effects of graded hypoxia are under investigation, since it has been noticed that asphyxia might reduce the extent of local loss of catechol in different regions.

Hence a variety of tissues, including skin and skeletal muscle, which, as regards their status in metabolism, must be considered rather poorly differentiated, are able to eliminate adrenaline and noradrenaline from the circulating blood. It seems fair to assume that the elimination of locally released transmitter substances at postganglionic sympathetic nerve endings might be still more successful.

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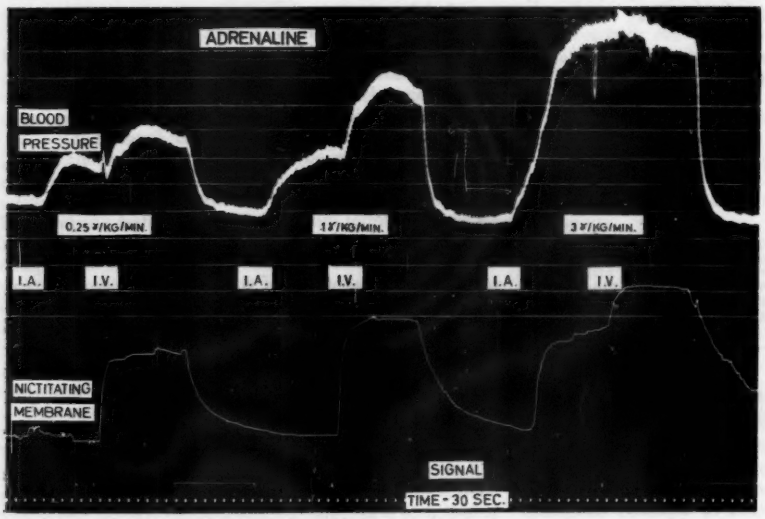

Fig. 1. Spinal cat, 3 kgm. Adrenals extirpated. Blood pressure at outset, 70 mm. mercury. Minimal effective dose of adrenaline on denervated nictitating membrane 0·1 μgm./kgm./min. intravenous. The records show the effects of three successive periods of adrenaline infusion into abdominal aorta versus intravenous infusion of the same concentrations

Metabolism of Two Aromatic Amines in the Dog

Clayson[1] has suggested that aromatic amines are carcinogenic by virtue of their transformation in the animal body into orthohydroxyamines. Walpole, Williams and Roberts[2] have shown that 4-aminodiphenyl is a potent inducer of bladder tumours in the dog, and Spitz (quoted by Walpole *et al.*[2]) has obtained bladder tumours in this species with benzidine. The purpose of this communication is to show that these aromatic amines are in fact converted into orthohydroxyamine derivatives by the dog.

4 : 4′-Diamino-3-diphenylyl hydrogen sulphate and 3-hydroxybenzidine were synthesized as follows. 4′-Nitro-4-aminodiphenyl was converted by oxidation with alkali and ammonium persulphate to sodium 4′-nitro-4-amino-3-diphenylylsulphate (found: loss on drying, 13·7; S, 8·4; $C_{12}H_9O_6N_2NaS.3H_2O$ requires loss 14·0; S, 8·3 per cent); 4′-nitro-4-amino-3-hydroxydiphenyl hydrochloride monohydrate (found: C, 51·2; H, 4·5; N, 10·2; $C_{12}H_{11}O_3N_2Cl.H_2O$ requires C, 50·8; H, 4·6; N, 9·9 per cent) obtained by hydrolysis was characterized as the diacetyl derivative (found: N, 8·8; $C_{16}H_{14}O_6N_2$ requires N, 8·9 per cent), melting point 189–190°. Sodium 4′-nitro-4-amino-3-diphenylylsulphate was reduced with ferrous sulphate and ammonia to 4 : 4′-diamino-3-diphenylyl hydrogen sulphate (found: C, 51·1; H, 4·2; N, 9·8; S, 11·2; $C_{12}H_{12}O_4N_2S$ requires C, 51·4; H, 4·3; N, 10·0; S, 11·4 per cent), which was hydrolysed to 3-hydroxybenzidine (found: N, 13·8; $C_{12}H_{22}ON_2$ requires N, 14·0 per cent), melting point 182–184°, tribenzoate (found: C, 77·3; H, 4·8; N, 5·7; $C_{33}H_{24}O_4N_2$ requires C, 77·3; H, 4·7; N, 5·5 per cent), melting point 270–271°. 4-Amino-3-diphenylyl hydrogen sulphate and 3-hydroxy-4-aminodiphenyl were prepared by the method of Boyland and Sims[3].

Urine from dogs fed 4-aminodiphenyl (200 mgm./day) has been chromatographed on paper in no fewer than ten solvent systems. In

all cases, only two spots could be demonstrated by spraying with a solution of *p*-dimethylaminobenzaldehyde. A very faint spot corresponded to 4-aminodiphenyl. This spot was strengthened when ether extracts of the urine were examined. The second more intense spot travelled at the same rate as 4-amino-3-diphenylyl hydrogen sulphate; hydrolysis of the urine by boiling with acid gave a new spot corresponding to 3-hydroxy-4-aminodiphenyl.

Urine from dogs fed benzidine (500 mgm./day) was chromatographed on paper in ten solvent systems. Three major and a number of other spots were demonstrated with the *p*-dimethylaminobenzaldehyde spray. Benzidine and 4 : 4′-diamino-3-diphenylyl hydrogen sulphate were shown to be important metabolites of the amine. 3-Hydroxybenzidine was shown to be present as a minor metabolite in some samples of urine. The other metabolites have not yet been identified.

Continuous ether extraction of the urine of a dog fed benzidine (500 mgm./day) for ten days enabled benzidine (400 mgm.; 8 per cent of the dose) and 3-hydroxybenzidine (85 mgm., 1·5 per cent) to be isolated. The benzidine, melting point and mixed melting point 124°, was characterized as the *p*-toluenesulphonate, melting point 241–242°, mixed melting point 242–243°. The monohydroxybenzidine, melting point 180–183°, was characterized as its tribenzoate, melting point 269°, mixed melting point 270–271°.

This work will be reported in detail later. We wish to thank Dr. G. M. Bonser for making available the biological material.

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Synergism in the Chemotherapy of *Eimeria tenella*

In 1954, Lux[1] investigated the possibility that potent inhibitors of *Eimeria tenella* might be found among compounds, other than sulphonamides, which interfered with the *p*-aminobenzoic acid – folic acid metabolic sequence. Lux found that a group of 2,4-diamino-pyrimidines possessed anticoccidial activity, one of the most active of the series being 2,4-diamino-5, *p*-chlorophenyl, 6-ethyl pyrimidine ('Pyrimethamine', 'Daraprim'). He noted, furthermore, that this compound, when used in combination with certain sulphonamides, had a marked synergistic effect.

At Weybridge, we have extended these observations with the view of developing effective systems of chemotherapy for disease caused by *Eimeria tenella*. In the past, 'Sulphamezathine' (sulpha-dimethylpyrimidine) has in our experience proved most satisfactory for treatment under practical conditions; but its use can be criticized on the grounds that the concentration necessary to obtain a maximum therapeutic effect is sufficiently high to cause some degree of inappetence, that occasional toxicity is observed[2], and that the full therapeutic concentration is liable to cause temporary inhibition of the parasite, development being merely delayed until treatment terminates[3,4]. Our observations, which have confirmed those of Lux[1], have shown that, although 0·01 per cent 'Daraprim' in the food affords only partial protection against *E. tenella*, the synergism between this substance and 'Sulphamezathine' permits the reduction of the concentration of both compounds to a fraction of that ordinarily needed for therapeutic control. Thus, in the presence of as little as 0·0025 per cent 'Daraprim' in the food, the concentration of 'Sulphamezathine' may be reduced to between $\frac{1}{2}$ and $\frac{1}{4}$ of that normally required for complete protection.

Temporary inhibition, with delayed clinical manifestations of disease, occurs with a mixture of 0·01 per cent 'Daraprim' and 0·05 per cent 'Sulphamezathine', but not when the concentration of 'Daraprim' in the mixture is reduced to 0·0025 per cent. This suggests that the combination of drugs at these low concentrations has a markedly selective effect on the later stages in the life-cycle of the parasite, leaving unimpaired the earlier stages, the development of which Kendall and McCullough[3] have shown to be essential for effective chemotherapeutic control.

These findings are likely to be of marked practical importance, and it seems that the use of the synergistic combination will avoid the difficulties associated with the present use of the sulphonamides.

The synergistic action on *E. tenella* of 'Daraprim' and 'Sulphamezathine' can probably be explained as the effect of two antimetabolites which act sequentially at different stages in the same metabolic pathway, at the points at which *p*-aminobenzoic acid and folic and folinic acids are concerned.

This would suggest a close analogy between the metabolism of *E. tenella* and those species of *Plasmodium* on which 'Daraprim' and some sulphonamides also exert a marked synergistic effect[5]. *p*-Aminobenzoic acid has already been shown to be an essential metabolite for *E. tenella* by the observation of Horton-Smith and Boyland[6] that the action of 'Sulphamezathine' may be antagonized by *p*-aminobenzoic acid. No facts are available on the importance of folic and folinic acids for *E. tenella*, although 'Daraprim' is regarded as an antagonist of folic and folinic acids in several other biological systems[7].

If, in fact, the metabolism of *E. tenella* is similar to that of the plasmodia, other anti-malarials may be able to replace 'Daraprim' in synergistic combination with sulphonamides or other drugs of known coccidiostatic value.

Studies on the above lines are proceeding.

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A Study of Normal Human Cerebrospinal Fluid by the Immuno-Electrophoretic Method

The immuno-electrophoretic method[1] allows the definition of the constituents of a mixture of antigenic substances by means of their relative electrophoretic mobilities, and their enumeration, by specific precipitation, by means of a homologous immune serum. The study of normal human serum by this method has allowed the enumeration of at least sixteen different constituents[2].

We have studied, by the same method, normal cerebrospinal fluid concentrated by ultra-filtration[3], by using horse immune serum (No. 31) anti-normal human serum, which has been used in the study of human serum. In a parallel manner we have submitted the same samples of cerebrospinal fluid to ordinary electrophoresis on agar under the same conditions as used for immuno-electrophoretic analysis. The agar gels were then dried, and the protein and lipid constituents were stained *in situ* by methods similar to those used previously[4].

The plain electrophoretic analysis in a gelified medium shows (Fig. 1) that the cerebrospinal fluid contains: a substance which migrates more quickly than albumin; much albumin; a small amount of α-globulins; β_1- and β_2-globulins and a small amount of γ-globulins.

Fig. 1

Fig. 2

The immuno-electrophoretic analysis (Fig. 2. allows us to distinguish the following: a constituent which migrates more rapidly than albumin and which would seem identical with the ρ-constituent of blood serum[2]; serum albumin; a constituent having the same mobility as albumin which is probably identical with the χ-constituent in blood serum[2]; one or probably two α_1-globulins; three α_2-globulins; at least one β_1-globulin; a single antigenic constituent having, however, two different migration-rates. This latter corresponds to the β_2-globulins and the small amount of γ-globulins which corresponds to the slow γ-globulins of the serum.

As we have used a total immuno-serum human antiserum, we could only distinguish in the cerebrospinal fluid constituents existing in the serum; there may also be other constituents specific to the cerebrospinal fluid. Our results do, however, demonstrate that the distribution of protein constituents in the cerebro-spinal fluid is not the same as in the serum itself.

Detailed results will be published in the *Bull. Soc. Chim. Biol.*

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Effect of Heat Stress on Serial Reaction Time in Man

Experimental studies of the effects of ambient temperatures on simple reaction time have suggested that there may be a negative correlation between simple reaction time and temperature, but results appeared to be rather inconclusive. In fact Teichner[1], in a review of studies of simple reaction time, concludes that ambient temperatures between − 50° and 117° F. have little or no effect on either simple reaction time or more complex reaction times.

In a series of experiments on the effects of ambient temperatures ranging from 90° to 104° F. (90–95 per cent saturation), we had occasion to study the effects of such temperatures on both simple reaction time and serial reaction time. In serial reaction time the signals are presented to the subject continuously with irregular occurrence of the signals to action, and without the warning signals customary in experiments on simple reaction time. It may reasonably be argued that serial reaction time is a more realistic measure than simple reaction time, since in the skills of everyday life we are seldom given warning of the arrival of a significant stimulus.

The apparatus used in these experiments was the Cambridge visual vigilance test[2], coupled to a photo-electric cell and a pulse-height discriminator operating a clock-starting relay. This gave a very accurate measure of reaction time.

Seven subjects were tested over a period of five days, serial reaction time being measured before entry into the heat chamber, after one hour exposure to the above range of temperatures, and after two hours exposure. For each measurement of reaction time the subject was presented with a large number of stimuli in a short time (forty stimuli in 5 min. in random order). The mean serial reaction times are shown in Table 1. It will be seen that the rise in reaction time under heat stress is small but statistically significant.

Table 1

	Mean serial reaction time (sec.)	*P*
Control	0·247	
First hour	0·256	
Second hour	0·267	
Control v. first hour		0·05*
Control v. second hour		0·01†
First v. second hour		0·05*

* Significant.
† Highly significant.

From these experiments we conclude that serial reaction time offers a clear-cut index of psychomotor change under heat stress of this order.

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Fixation of Iodine in Selenium

The following observations were made in carrying out some tracer experiments on the selenium–iodine system, using the radioactive isotope iodine-131.

It was found that iodine could be adsorbed on to selenium powder from a solution containing iodine-131, and measurements of the total γ-ray activity of a sample of the selenium were made: (i) after the powder had been thoroughly dried; (ii) after it had been melted and at once cooled to an amorphous solid; and (iii) after further heating in an open tube for 7 hr. at 550° C.

No significant differences were found among the three activities, from which it was concluded that less than 1 per cent of the iodine initially present was removed during the heat treatment. An autoradiograph of a section through the specimen at the end of the experiment showed a macroscopically uniform distribution of iodine-131 activity.

This evidence supports the generally accepted view that halogen atoms can be bound in the selenium structure, probably at the ends of chains of selenium atoms. If it is assumed that iodine and bromine behave similarly in this respect, this conclusion does not agree with that of Nijland[1], who states that no stable bonds exist between selenium chains and bromine atoms.

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Production of Anisotropy in a Permanent Magnet by Pressure

H. P. J. Wijn and others[1] have described a novel method of making 'Ferroxcube' with a square hysteresis loop. Glass with a higher coefficient of expansion than the 'Ferroxcube' was fixed to a ring-shaped sample at an elevated temperature; the resulting strain at room temperature produced a square hysteresis loop. An experiment has been performed to show that a similar effect is possible with a permanent magnet alloy.

Since a large magnetostriction appeared necessary, 35 per cent cobalt steel was chosen for the experiment. The magnetostriction is positive, and in consequence a longitudinal tension or a lateral pressure will favour a square loop. A lateral pressure was obtained in a bar of cobalt steel about $1\frac{1}{4}$ in. long and $\frac{1}{4}$ in. in diameter in the following manner. A hole 0·002 in. less in diameter than the cobalt steel was made in a stainless steel block. This block was heated to 450° C., the cobalt steel was cooled in liquid air and the stainless steel block was shrunk on to the cobalt steel specimen. The cobalt steel had been previously

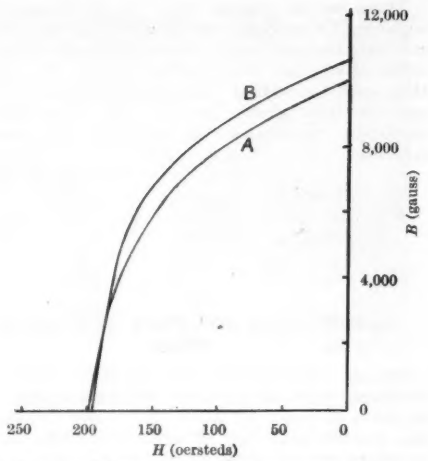

Fig. 1. (*A*) Normal curve; (*B*) under compression

hardened, aged at 150° C. and cooled in liquid air before testing, so that any changes in properties after the shrinking are likely to be due to the pressure and not to the temperature cycle during the shrinking operation.

The test values obtained are shown in Fig. 1.

The improvement obtained by pressure, although not spectacular, is amply demonstrated.

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Localized Corona Discharges at a Negative Electrode

The form of the d.c. corona discharge in air differs according to the polarity of the electrode near which it occurs. In an electrode system comprising a wire and a coaxially mounted ring, the discharge appeared as a continuous bright sheath around the wire when it was positive, but as a series of separate tufts when it was negative with respect to the ring.

In an investigation of the latter effect, a jet of mercury was substituted for the wire, giving a clean and smooth electrode surface which was also moving rapidly with respect to the electric field. With the jet negative to the ring, no stationary tufts were observed. It was confirmed by photography with a flash of microsecond duration that the jet, though not accurately parallel-sided, was smooth in the region where discharges occurred. The influence of the moving layer of air at the surface of the mercury jet was simulated by blowing air from a nozzle along a wire at the surface of which tufted discharges were occurring, the effect being that the tufts persisted but with some vibration along the wire.

The nature of the light emitted was investigated with a photomultiplier, wide-band amplifier and oscilloscope and was found to be similar in the cases of both jet and wire. It consisted of pulses, of duration about 10^{-7} sec., separated by irregular intervals having durations of microsecond order.

These results suggest that the localization of the negative d.c. corona is an effect due to the electrode, and that the mechanism of the discharge is not much different whether it is localized or not. It is surmised that each individual discharge is associated with a cathode spot which, in the case of a stationary electrode, maintains its position by thermionic emission.

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Specific Heat and Heat of Wetting of Wood

Kelsey and Clarke[1] have recently discussed the variation with temperature of the integral heat of sorption of water by wood (ΔH), and its bearing on the specific heat (c_m) of wood containing m gm. of moisture per gm. of dry wood. Empirically, it is found that c_m is greater than the specific heat (c) calculated from the specific heats and proportions of the components, assuming a simple mixture law[2]. This effect is not confined to cellulosic materials, but has been observed on starch[3], gelatin[4], dried foods[5] and other hygroscopic substances. The suggestion has previously been made[5] that the excess specific heat could be accounted for in terms of the change in ΔH with temperature (T); Kelsey and Clarke quote the appropriate thermodynamic equation as

$$c_m = \frac{1}{1+m}\left\{mc_w + c_0 + \left(\frac{\partial \Delta H}{\partial T}\right)_{p,m}\right\}$$

where c_w is the specific heat of the water, and c_0 is the specific heat of the dry wood. Putting $c_w = 1$, and noting that

$$c = (m + c_0)/(1 + m), \qquad (1)$$

then

$$c_m - c = \Delta c = (\partial \Delta H/\partial T)/(1 + m) \qquad (2)$$

where Δc is the excess specific heat.

During the past two years, we have measured the specific heat and heat of sorption of a batch of beech sawdust as a function of temperature and moisture content[3,6]. Our results enable a direct check on equation (2) to be made (Table 1).

Measurements at temperatures of 30, 40, 50, 60° C. gave $c_0 = 0{\cdot}31$, $0{\cdot}32$, $0{\cdot}33$ and $0{\cdot}34$, respectively. The values of Δc in Table 1 were obtained by computing c from equation (1) and subtracting it from the observed specific heat (c_m). The values of $(\partial \Delta H/\partial T)/(1 + m)$ were obtained by plotting ΔH at a given moisture content against temperature, fitting a curve by eye and differentiating graphically. The error in the measurement of c_m is estimated to be about 0·005; but owing to the accumulation of errors in the measurements, in drawing the curves, and in the graphical differentiation, the uncertainty in $(\partial \Delta H/\partial T)/(1 + m)$ is at least 0·01. To the accuracy of the results, therefore, the values in Table 1 satisfy equation (2) completely.

Table 1

m	T (° C.)	Δc	$(\partial \Delta H/\partial T)/(1+m)$
0·107	30	0·02	0·02
	40	0·02	0·02
	50	0·02	0·03
	60	0·04	0·05
0·140	30	0·02	0·02
	40	0·03	0·03
	50	0·03	0·04
	60	0·06	0·05
0·216	30	0·03	0·03
	40	0·04	0·04
	50	0·05	0·06
	60	0·08	0·07
0·310	30	0·04	0·05
	40	0·05	0·06
	50	0·06	0·07
	60	0·09	0·09

Equation (1) is often used for calculating the specific heat of wood for technical applications[7]; but this procedure can evidently lead to errors of the order of 10 per cent. The general agreement between our results and those of Kelsey and Clarke, obtained on an entirely different species, is good, and suggests that the specific heat of wood containing moisture will not depend greatly on species. This suggestion is supported by the work of Dunlap[8], who found the specific heat of dry woods to be practically independent of species.

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Canals within Pancreas Cells

There have recently appeared in *Nature* and elsewhere articles by Lacy[1] describing canals within pancreas cells. These he believes represent the Golgi apparatus; and he has published[2] an electron photomicrograph purporting to show one of these "Golgi canals" in section.

In point of fact, intracellular canals have been described in the pancreas by numerous observers, especially Müller[3] and Holmgren[4]; but the possibility that the Golgi apparatus of the pancreas cells may be no other than a deposit of silver or osmium upon the pre-existing canals of a functional intracellular duct system seems to have been overlooked by most workers, with the exception of Saguchi[5]. Lacy, however, has overlooked Saguchi's classical study, though he has undoubtedly re-described the same intracellular canals depicted by the Japanese worker. Further, Lacy assumes in contradistinction a physiological function for his "Golgi canals" by postulating a role for them in a "lipoidal secretion cycle". He also claims that his discovery of the canals necessarily disproves the Golgi artefact theory.

In order to test Saguchi's conclusions, I have attempted to inject the intracellular canals from the pancreatic ducts with a 'mass' consisting of a laked blood medium. After sectioning, the hæmatin was revealed by staining the preparations with a hæmatoxylin solution. This procedure was found to give a brilliancy and precision hitherto unobtainable

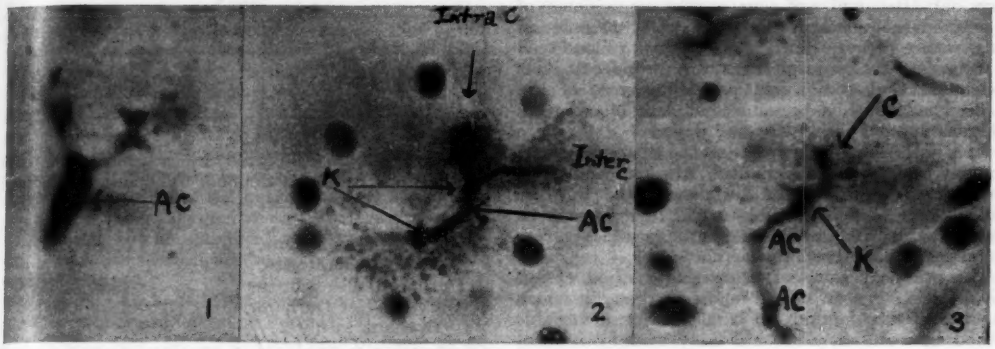

Fig. 1. Injected cat pancreas. Two intracellular saccular 'cisterns' communicate with the acinar cavity (*AC*) by fine canals. × 3,000

Fig. 2. Transverse section of an injected acinus. Acinar cavity (*AC*); vacuoles of Kupffer (*K*); intracellular canaliculi (Intra *C*); intercellular canaliculus (Inter *C*). × 1,500

Fig. 3. Intracellular canals and 'cisterns' (*C*) drain to the acinar cavity (*AC*) through a Kupffer vacuole (*K*). × 1,500

with simple carmine gelatine media. Details of this method will be published elsewhere.

In the sections, in numerous instances, both intercellular and intracellular canals can be seen clearly communicating with the acinar cavity. For the most part the intercellular canaliculi end blindly but have lateral extensions which enter the cells and run among the zymogen granules. In other instances fine canals lying between the zymogen granules unite and drain via a single intracellular canal to the exterior. Sometimes the cells contain a single irregular saccular space within the cytoplasm and this may receive smaller tributaries from among the granules. These saccular spaces then drain to the acinar cavity by means of a fine canal. Fig. 1 shows two examples of this arrangement revealed within adjacent acinar cells.

The secretion vacuoles of Kupffer, observed also by Müller and Saguchi, occur frequently in my material. They usually receive one or more intracellular canals (Fig. 2). In Fig. 3 some intracellular saccular spaces together with tributary branches enter a Kupffer vacuole before draining to the acinar cavity.

The saccular spaces revealed by this method appear to be interposed on a more delicate and elaborate system of intracellular canals which penetrate the cell in all directions. Their appearance suggests that they may act as cisterns for the temporary storage of materials destined for secretion. Undoubtedly these saccular spaces are often preserved in ordinary preparations, but their communications remain invisible and the isolated spaces give the impression of structures intrinsic to the cytoplasm. Similar spaces have often been described in endocrine cells, as in the curious 'signet ring' basophil pituitary cell. These spaces are possibly homologous structures for the holding of partly elaborated secretions, and would serve a purpose similar to the thyroid vesicle, but on an intracellular scale.

I would suggest that my findings support Saguchi's belief that a functional duct system of exogenous origin occurs within the acinar cells of the pancreas. The finest ramifications of this system appear commensurate with the smallest zymogen granules, and they thus agree in size with the canals recently photographed with the electron microscope.

It is becoming increasingly clear from recent studies[6,7] that the metallic impregnation techniques so long used as an indicator of the 'Golgi apparatus' do in fact colour quite unrelated and dissimilar objects in different cells. Lacy has shown that the canals within the acinar cells are preserved and blackened by a number of Golgi techniques, but reliance on the supposed specificity of these methods has, I believe, led Lacy into a mistaken conception of the nature of his canals.

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Behaviour of Young and Old Females of the Black-fly, *Simulium ornatum* Mg.

Considerable attention has been devoted to devising means of determining the age of mosquitoes[1] and tsetse flies[2] in the course of studies on their ecology and behaviour, particularly in relation to disease transmission. By observing the distribution and quantity of fat-body in the black-fly, *Simulium ornatum* Mg. (Diptera, Simuliidae), it has now been possible to achieve some degree of age determination in this blood-sucking insect also.

Female flies taken on cattle in the field can be divided into two main groups on dissection, namely, those with visible fat-body particularly in the anterior abdominal segments (group *A*), and those with no fat-body, except in small amounts in the posterior abdominal segments (group *B*). Some 0–10 per cent of the flies in particular samples were intermediate and could not be allocated to either group. On emergence from the pupa, females invariably possessed abundant fat-body. Laboratory studies on the disappearance of the fat-body in flies of known age suggest that group *A* consisted of young flies, perhaps not more than seven to ten days old, and that the *B* group was composed of individuals at least ten

days old. Residual ripe eggs, conclusive evidence of a previous complete gonotrophic cycle, were found only among *B* flies. Since in *S. ornatum* a blood feed is necessary before ripe eggs are produced, it is concluded that some, and probably most, of the *B* flies had taken a previous complete blood meal, whereas none of the *A* flies had done so.

It is interesting to note that the changes in the amount of fat-body in female *S. ornatum* appear to form the converse of the situation found in male tsetse flies, where the initially small reserves may be augmented considerably by synthesis of fat after blood feeds have been taken[3].

The practical value of using this method of age classification is seen in the following data, in which the age of flies landing on cattle during a variable period between morning and early evening is compared with the age of those landing on cattle during the last ½–1½ hours of daylight. The pooled results for sixteen days in 1954 show that old flies formed a higher proportion of the catch during late evening (see Table 1). The greater number of flies containing residual ripe eggs in the late evening catches confirms this finding (Table 2). When the days are considered separately, a significant late-evening increase in the proportion of old flies occurred on only eight of these days (P within range 0·01 to $< 0·001$). On the sixteen days the total catch of *S. ornatum* per unit time on cattle was often greater in late evening than during the day, paralleling the situation shown for *S. venustum* Say on man in Canada[4]. This increase in activity thus coincided with the occurrence of a greater proportion of old flies in the catch, and the number of old flies visiting the cattle per unit time became 1·2–12·0 times greater in late evening than during the day.

Table 1

Flies taken during 1–3 hr.* within the period 10.00–18.00 hr.			Flies taken during ½–1½ hr. in late evening (18.00–21.00 hr.)		
A Flies	*B* Flies	Unclassified	*A* Flies	*B* Flies	Unclassified
724	253	29	579	542	28

Ignoring unclassified flies, $\chi^2 = 110·88$; $P = < 0·001$.
* The longer period was necessary in order to obtain fly numbers high enough for statistical analysis.

Table 2

Flies taken during 1–3 hr. within period 10.00–18.00 hr.		Flies taken during ½–1½ hr. in late evening (18.00–21.00 hr.)	
No. containing residual eggs	Total flies	No. containing residual eggs	Total flies
37	1,006	111	1,149

$\chi^2 = 29·08$; $P = < 0·001$.

It would appear that in the case of an organism transmitted by the bite of *S. ornatum*, a susceptible host would have been exposed to a far greater number of potentially infective bites per unit time in late evening than during 10.00–18.00 hr. on the days in question.

The readiness of young and old flies to bite a cow was compared by recording the frequency with which fresh blood was found in the gut of flies of each group, which were given the opportunity to bite during approximately 10 min. of each hour of the observations. The results of dissecting 3,702 flies taken on eighteen days in 1954 (Table 3) show that old flies bit the cow almost twice as frequently as did young flies on average over the period.

Table 3

	A Flies	*B* Flies
No. flies taken	2,448	1,254
No. containing fresh blood	80 (=3·27 per cent)	80 (=6·38 per cent)

$\chi^2 = 18·67$; $P = < 0·001$.

This work was financed by a grant from the Agricultural Research Council. The full results will be published elsewhere.

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Physiology of the Heart of a Scorpion

In view of the fact that scarcely anything is known about the physiology of the hearts of arachnids except that of *Limulus*[1], the present investigation on the nature of the heart of *Palamnaeus bengalensis* C. Koch and the effects of stimuli, *p*H and drugs on it was undertaken. The hearts were isolated in a saline (*p*H 6·3) containing sodium chloride, 0·65 gm., potassium chloride, 0·03 gm., and calcium chloride, 0·03 gm. in 100 c.c. of distilled water and the *p*H maintained with a phosphate buffer. The hæmolymph was found to be on the acid side of neutrality, in agreement with Maluf's statement[2]; hence the selection of an acidic saline. Heart-beat after isolation was slow and irregular for nearly ten minutes. On recovery, it showed a high degree of automatic movement with incessant rhythmic and simultaneous beat throughout the myocardium, at a rate of 56–62/min. at room temperature (25–27° C.), without rest pauses. After 10–12 hr. its rate and amplitude fell gradually. After temporarily inhibiting the heart-rate by such mechanical stimuli as shaking the saline or pressing the heart, there was acceleration of the rate of beat. Isolated pieces of the heart beat for some time.

Both increasing and decreasing the *p*H of the saline with phosphate buffers depressed the heart-rate, and increase of temperature accelerated the heart-rate. The upper limit was 80–85 beats/min. at 42° C.; the lower limit on cooling was 4–5 beats/min. at 5° C., but it recovered on increasing the temperature.

Stimulation of the brain and ventral nerve cord by passing electrical current did not affect the rate of beat of the heart *in situ*. It also had no effect on direct application to the heart, up to 2 V. Further increase in the intensity of the stimulus in the latter case stopped the heart-beat. On switching off, the heart-beat reappeared after about 15 min. Electrically stimulated hearts were not used for drug experiments.

The effects of various drugs were observed on hearts both *in situ* and isolated. Acetylcholine at 10^{-8} dilution or stronger depressed the rate of beat, but the heart recovered after washing with saline. At higher dilution acetylcholine had no effect. By first treating hearts with higher dilutions and then gradually

increasing the concentration, tolerance to acetylcholine up to 10^{-4} dilution was observed. The action of acetylcholine was potentiated by physostigmine (10^{-4}). Histamine (10^{-4}) accelerated the heart-rate and antagonized the action of acetylcholine. Adrenaline (10^{-5}) accelerated, atropine (10^{-4}) inhibited and ether (half and fully saturated) had no effect on the heart-beat. On many occasions the best agent for reviving a collapsing heart was warm saline, which was added in drops to the heart container. The time of recovery varied from five to fifteen minutes.

According to the classification of hearts by Needham[3], the scorpion heart may be put among the myogenic types.

A detailed account of this work will be published elsewhere. I am indebted to Prof. M. B. Lal, University of Lucknow, for his interest and to Prof. K. N. Ojha, Medical College, Cuttack, for help in carrying out some of the experiments. I thank the B.S.I.R., Orissa, for financial aid.

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Apparent Resistance of a Snail to Infection in the Gold Coast

In recent years, detailed studies have been conducted on schistosomiasis and its snail vectors in the Gold Coast. The results of surveys throughout the territory show that although *Schistosoma hæmatobium* and *S. mansoni* are both endemic, the former infection, together with its snail hosts, *Physopsis africana* and *Bulinus* sp., *sensu stricto*, is considerably more widespread than the latter and its planorbid vector, *Biomphalaria pfeifferi*[1].

During snail surveys it was observed that *Bulinus* (*Pyrgophysa*) *forskalii* is widely distributed, and as this species is a vector in the Gambia[2] and in Mauritius[3,4], its role in the local transmission of schistosomiasis may well be suspected. The results of field observations in the Gold Coast were equivocal. For example, at Dabala, Adutor and other villages in the Tongu district, a high incidence (50–90 per cent) of *S. haematobium* infection occurs in the local children. In this area only *B.* (*P.*) *forskalii* could be found, despite a thorough search during both wet and dry seasons for the principal vectors, *P. africana* and *Bulinus* sp., *s.str.* Thus in the Tongu district, at least, the results of the field surveys pointed to *B.* (*P.*) *forskalii* as the potential vector. In other districts *B.* (*P.*) *forskalii* alone were commonly recorded in ponds used frequently by people in whom *S. haematobium* infection is very rare. In these districts there is no evidence that effective transmission occurs in the presence of *B.* (*P.*) *forskalii* alone. None of several thousand *B.* (*P.*) *forskalii* collected in the Gold Coast has been found infected with mammalian schistosome cercariæ.

In view of these findings and the conflicting evidence regarding the susceptibility of *B.* (*P.*) *forskalii* to *S. haematobium* in other African territories[4], controlled transmission experiments using laboratory-bred snails are being undertaken in Accra. The results of four typical observations are described below.

(1) Twenty half-grown *B.* (*P.*) *forskalii* were exposed for 5 hr. to large numbers of miracidia of *S. haematobium* derived from infected children at Pokoasi, near Accra. At frequent intervals from the twenty-second day until the forty-second day after exposure, the snails were examined for the emergence of cercariæ, but none was observed during the period. Thereafter the snails were killed and dissection showed them to be free of parasites.

(2) Thirty similar snails were exposed on three successive days in the same manner as those in the first experiment. Using the same method of detecting infection, it was again observed that none of twenty-five snails that survived the period of observation was infected.

(3) Twenty *B.* (*P.*) *forskalii* and twenty *P. africana*, bred in the laboratory, were exposed for 4 hr. to *S. haematobium* from Pokoasi children. During the period of exposure, both species were kept in the same dish. Eighteen *P. africana* snails afterwards shed cercariæ, but none of the *B.* (*P.*) *forskalii* became infected.

(4) Twenty-five *B.* (*P.*) *forskalii* and twenty *Bulinus* sp., *s. str.*, were placed together in the same dish and exposed overnight to *S. haematobium* miracidia derived from children in a district where both species are found. All the *Bulinus* sp. later shed cercariæ but none of eighteen surviving *B.* (*P.*) *forskalii* became infected.

In summary, attempts to infect laboratory-bred *B.* (*P.*) *forskalii* from the Gold Coast with local strains of *S. haematobium* were unsuccessful even though it seemed that the parasites could develop readily in both *P. africana* and *Bulinus* sp., *s. str.*, snails also bred in the laboratory.

The varying susceptibility of the Bulininae and Planorbinae to *S. haematobium* and *S. mansoni* respectively is a puzzling problem not yet understood. For example, an important snail host in one country may be refractory or only slightly susceptible to the same species of schistosome from another region[5]. Alternatively, snails of the same species in different regions may be either susceptible or resistant to local strains of the same schistosome. In the Sudan, Archibald and Marshall[6] record that *P. africana* were refractory to *S. haematobium*; yet these snails are the principal vectors of the parasites in the Gold Coast. In respect of *B.* (*P.*) *forskalii* and its relationship to *S. haematobium*, a similar picture seems to exist. As already mentioned, *B.* (*P.*) *forskalii* from the Gambia and Mauritius are susceptible to *S. haematobium*, but in the Gold Coast and in Tanganyika[7] they appear to be refractory.

The explanation of the susceptibility or resistance of the potential vectors to their schistosome parasites must lie either with the snails or with the parasites. First, as our knowledge of the taxonomy of the snail hosts is still rudimentary, it may be argued that the 'species' of snails in the different regions are morphologically or biologically distinct and accordingly are either susceptible or resistant to infection. If this is true, *B.* (*P.*) *forskalii* in the Gold Coast may be different from *B.* (*P.*) *forskalii* in the Gambia and in Mauritius, although this difference, if it exists, is not yet determined. Secondly, it may be argued that several strains of *S. haematobium* exist, each having an affinity—perhaps to the extent of being specific to a certain host—for a particular species of snail. If this is true, it may be assumed that the strain of *S. haematobium* in the Gambia and in Mauritius coincides there with its particular snail host (*B.* (*P.*)

forskalii), whereas in the Gold Coast this strain of the parasite is rare or absent.

It is evident that the greatest care must be taken before any bulinid species can be removed from the list of vectors, and at Accra attempts are continuing to be made to infect *B.* (*P.*) *forskalii* with *S. haematobium* derived from many different districts, including that of Tongu. To date, however, there is no direct evidence that *B.* (*P.*) *forskalii* can transmit the parasites in the Gold Coast.

I am grateful to the Chief Medical Officer, Gold Coast, for permission to publish these observations.

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Unilateral Hybridization

Species hybrids have been reported in *Petunia*[1] and *Lycopersicum*[2] which can only be made in one direction, namely, when the self-fertile species of the pair is used as female parent and the self-incompatible one as male[3]. This phenomenon, which may be called 'unilateral hybridization', also occurs with some species of *Antirrhinum*.

The *Antirrhinum* species have been classified[4] into four groups:

(1)	Antirrhinastrum	$2x = 16$
(2)	Orientalis	
(3)	Orontium	
(4)	Asarina	$2x = 18$

In the Antirrhinastrum group, which includes most of the species, all the species are either self-incompatible, or have a history of self-incompatibility. The second group, Orientalis, which is represented by *A. siculum*, and the third which only includes *A. orontium*, are both self-fertile. The fourth group, containing only *A. asarina*, is also self-fertile; but this has a different chromosome number and has never been shown to hybridize with any other species. Six species from the Antirrhinastrum group have been crossed reciprocally with *A. siculum* and *A. orontium* and pollen tube growth observed.

From the results in Table 1, it will be seen that the pollen tubes of the self-fertile *A. orontium* and *A. siculum* species are greatly inhibited in the styles of the self-incompatible Antirrhinastrum species. By contrast, in the reciprocal crosses, when the self-fertile is the female parent, the pollen tubes grow right through the style and in two cases produce viable seed.

The flowers of *A. orontium* and *A. siculum* are much smaller than the self-incompatible species, and *A. orontium* is practically cleistogamous. *A. majus*, a species from the self-incompatible Antirrhinastrum group, needs special mention because intensive cultivation has selected self-fertile mutants with large flowers; but the intrinsic self-incompatibility of both its style and pollen is apparent from the interspecific crosses. Its style rejects the pollen of the self-fertile *A. orontium*, and its pollen grows normally in all the self-incompatible species.

Table 1

♂	♀ *A. siculum*	♀ *A. orontium*	♂ *A. siculum*	♂ *A. orontium*	♀
Antirrhinastrum					
A. majus	⊕	+	−	−	*A. majus*
A. ramosissimum	+	+	−	−	*A. ramosissimum*
A. linkianum	+	+	−	−	*A. linkianum*
A. meonanthum	+	⊕	−	−	*A. meonanthum*
A. glutinosum	+	+	−	−	*A. glutinosum*
A. molle	+	+	−	−	*A. molle*
A. siculum	⊕	+	⊕	+	*A. siculum*
A. orontium	+	⊕	+	⊕	*A. orontium*

−, Pollen tubes greatly inhibited.
+, Pollen tubes grow through style.
⊕, Viable seed produced.

The *A. orontium* × *A. meonanthum* hybrid ($S_F \times S_I$) which in appearance is nearly identical with the mother parent, is sterile due to failure of chromosome-pairing at meiosis. S_I pollen from *A. meonanthum* can grow through the hybrid styles, but pollen from S_F *A. orontium* is inhibited. This is similar to the behaviour of the *Lycopersicum esculentum* × *L. peruvianum* hybrid[5]. In the *Antirrhinum* allotetraploid, chromosome pairing is restored and 16 bivalents are found; but the plant is self-incompatible. The allotetraploid produces S_{FI} pollen and this is inhibited in S_{FFII} styles. This could be due to either the self-incompatibility alleles from *meonanthum* still functioning in the allotetraploid's genetic background, and/or the inhibition of *orontium*'s self-fertility allele by the self-incompatibility allele of *meonanthum*, both alleles being present in the pollen grains and styles of the allotetraploid.

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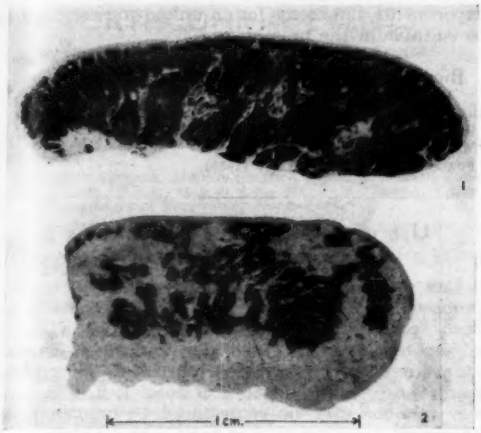
Reproductive Organs of Fœtal and Juvenile Elephant Seals

Between 1953 and 1955, I was serving with the Falkland Islands' Dependencies Survey in South Georgia and material was collected from the southern elephant seal, *Mirounga leonina*. Histological and histochemical examinations are being made of parts of the reproductive tracts and various endocrine organs from fœtal, juvenile and adult seals. Material fixed in acetone for fourteen months and kept within a few degrees of freezing point is still giving strong alkaline phosphatase reactions.

A hypertrophy of the gonads of the elephant seal occurs in fœtal life, similar to, but less marked than, that observed by Amoroso, Harrison, Matthews and Rowlands[1] and Harrison, Matthews and Roberts[2] in the common seal, *Phoca vitulina*, the grey seal *Halichoerus grypus* and various antarctic species.



(1) Section of ovary of fœtal elephant seal, about ten days antepartum. (2) Section of ovary of elephant seal 29 days old. Both sections stained to show localization of alkaline phosphatase (black). The scale represents 1 cm.

The ovaries of a full-term fœtus, 142 cm. in length, weighed 6 gm. each; an ovary from a 2-day pup weighed 4·5 gm.; the right ovary of a 29-day pup weighed 3 gm. The ovaries of a yearling elephant seal weigh 5·5 and 6 gm. each. In the adult, the average weight (six measurements) of the ovary not containing either a corpus luteum or a ripe follicle is nearly 7 gm. Thus the ovary of the full-term fœtus is nearly as large as the inactive ovary of the mature animal.

Similar changes are apparent in the male gonad and prostate. A full-term male fœtus had testes weighing 18 gm. and 18·5 gm., and the prostate weighed 25·5 gm.; in a neonatal specimen the testes weighed 10·5 gm. each and the prostate 20·5 gm.; in a 7-day pup the right testis weighed 17 gm. and the prostate 13 gm.; in a 2–3-week old pup the testes weighed 15·5 gm. and 15 gm. and the prostate 12·5 gm. The adult gonad weighs about 500–600 gm. and the prostate 300–600 gm.

A reduction in the size of the infantile adrenals takes place in the first few days after parturition. The adrenals of a full-term female fœtus weighed 8·5 and 12·5 gm.; those of a 2-day pup, 9 gm. and 8·5 gm.; of a 14-day pup, 4 gm. and 4 gm.; of a 29-day pup, 5 gm. and 6·5 gm. The adrenals of a yearling cow weighed 7·5 gm. and 10 gm. and those of an adult cow (not pregnant or lactating) 7 gm. and 7·5 gm. In the male, the fœtal adrenals weighed 12·5 gm. and 14 gm.; at 7 days, 8 gm. and 7 gm.; at two to three weeks, 6·5 gm. and 8 gm. The adrenals of an adult male weighed 41·5 gm. and 51 gm.

In the full-term fœtal ovary, the main bulk of the gland is composed of interstitial tissue surrounded by a narrow fibrous tunic about 150–200μ across and containing scattered young follicles. The interstitial cells show great phosphatase activity, but the cortical region is practically free from phosphatase. The follicles are generally free from phosphatase, but occasional ones show slight activity; these are believed to be atretic. Subcortical crypt formation is slight compared to that observed by Harrison and Matthews[3] in other seals. Ovaries from older seals show a decline in the amount of interstitial tissue and a reduction in phosphatase activity. In a three-week ovary the interstitial cells are separated by fibrous tissue into small islets. At this stage healthy Graafian follicles have all but disappeared, though a number of primary follicles are to be found.

The testis of a full-term elephant seal is surrounded by a tunic 1·0–1·2 mm. in thickness. The gland is composed almost entirely of closely packed convoluted tubules. These are between 50 and 60μ in diameter and have no lumina. The interstitial tissue is very scanty and the individual cells are small. The development of this tissue is not nearly as marked as in the common and grey seals[2]. Testes of 7-day and 21-day pups present a not dissimilar picture, the rapid involution in the female gonad not being nearly as marked in the male.

The prostate of the full-term fœtus shows considerable activity. Most of the tubules have irregular lumina and contain inclusions, in some cases cellular debris. In the 21-day old specimen the tubules are smaller, the lumina have become more nearly circular in section and the amount of connective tissue has increased greatly so that it forms the bulk of the gland. The tubules are either empty or contain a little eosinophilic substance, not found in younger specimens.

In the epididymis of the full-term fœtus the tubules are about 150μ in diameter with a columnar epithelium 20–30μ in height. In the 21-day old epididymis the tubules are reduced in size; the epithelium is only about 10μ in height and the tubules contain a number of cells in their lumina.

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Plant Growth on 'Fly Ash'

In a communication outlining research on plant growth on 'fly ash' published in *Nature* of August 20, p. 352, by Rees and Sidrak[1], the following statement was made: "but as yet no attempt seems to have been made to examine its plant nutrient properties as compared with those of a normal soil". Work on various aspects of reclamation of land covered with 'fly ash' is, however, in progress at Leeds under a grant made available for the purpose by the Central Electricity Authority.

The investigations are following two main lines: (*a*) field-plot experiments designed to test the effect on plant growth of using soil coverings of various depths, together with incremental fertilizer dressings, upon 'fly ash' settling ponds; various crop plants are used in the experiments; (*b*) pot, and afterwards plot, experiments investigating the possibility of rendering the 'fly ash' in itself a medium suitable for plant growth.

Under the second heading possible methods of ameliorating the toxic properties of the material are being tried out, along with the effects of adding combinations of plant nutrients in standard factorial experiments. The work at Birmingham reported by

Dr. Rees has provided valuable information for this work. While it would be premature to report the result of the experiments, it can be stated that confirmation of the presence of manganese and aluminium toxicity has been obtained at Leeds.

A matter of general interest is that the manganese and aluminium toxicities found in the 'fly ash' are associated with high alkalinity, namely, *p*H 8·5 and higher in the Leeds samples. Manganese and aluminium toxicities in Britain are usually part of the 'toxicity-deficiency' complex of acid soils. There are reports of aluminium toxicity from some of the alkali soils of the United States, however[2]. Preliminary results in pot-experiments suggest that reduction of the *p*H by various means has a considerable effect upon these toxicities and can lead to increased plant growth.

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A New Imino-Acid in some Liliaceae

Linko and I[1] isolated, last autumn, from *Polygonatum officinale* (and also from *Convallaria majalis*), a new imino-acid which on acid hydrolysis gave mostly homoserine. The elementary composition of the new compound corresponded to the formula $(C_4H_7O_2N)_n$ and had $[\alpha]_D^{20} - 118{\cdot}4°$ (in water). The compound had all its carboxyl groups free and contained no primary but only secondary amino-groups. Because the compound contained no double bonds, it must have a cyclic structure. A 4-membered ring containing an imino-group and a free carboxyl group linked to the ring could have satisfied the formula, but using the method of Wendt[2] a molecular weight of approximately 300 was found, which is three times as high as that calculated for the simple molecule (six determinations in concentrations of 0·63–2·22 per cent in a non-polar solvent, the lactam of 4-amino-*cyclo*-hexane-carboxylic acid; calculated for $(C_4H_7O_2N)_3$, 303·3). On the basis of the molecular weight found, the compound seemed not to contain a simple 4-membered ring, even if all other known facts suggested this structure, but a corresponding ring three times as large and with three imino-groups in a ring to which three free carboxyl groups were linked. There was no other possibility of explaining the high molecular weight.

Fowden[3] isolated recently the same compound from *Convallaria majalis* without knowing of our work. His results are in good agreement with ours, with one important difference. Using the method of Barger, he found a molecular weight of approximately 100 for the compound, which thus probably contained a 4-membered ring containing an imino-group, and also a free carboxyl group. He has confirmed this conception by comparing the isolated compound with synthetic azetidine-2-carboxylic acid.

There is no doubt about the identity of the compounds isolated by us and Fowden. The three-fold molecular weight found by us is apparently wrong. The method of Wendt gave a correct molecular weight for some dipeptides and amino-acids in control experiments, but seems for an unknown reason not to be suitable in the present case.

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Use of a Computing Machine as a Mechanical Dictionary

The method for locating 'words' in a 'dictionary' proposed by Booth in his recent communication[1] has been standard practice for a long time in coding edge-punched cards used for indexing scientific literature and for many other purposes. Thus, if one denotes a consecutive series of holes 1, 2, 4, 8, . . . , any number may be represented by punching the appropriate combination of holes with a ticket punch so that they become slots communicating with the edge of the card; for example, the number 678 would be indicated by slotting 2, 4, 32, 128, 512. To find a desired card, it is necessary to ask N 'questions' if the numbers run up to $(2^N - 1)$; in practice, one inserts a knitting needle into each hole in turn, rejecting or retaining (as appropriate) cards which remain hung up on the needle when the pack is lifted from the table and shaken.

The system has another interesting property[2]: that $(2^N - 1)$ cards can be sorted into perfect serial order by only N successive operations of one needle. Thus if there are up to 1,023 cards, the code will consist of ten holes, denoted 1, 2, 4 . . . 512. To sort the cards, one inserts a needle in the hole 1; all cards which drop out of the pack when it is lifted are replaced behind it without disturbing their order. This operation is repeated with the hole 2, the order of the cards being carefully preserved, and so on along the series. After the hole 256 has been dealt with, it will be found that the pack is in exact numerical order; to sort the 1,023 cards required only ten operations. It is a consequence of the method of representation of the numbers that in theory the economy of the method increases as the number of cards become greater—even though in practice the mechanics may become more difficult. To take the example of Booth's lecture demonstration[1], a set of cards, on each of which was written a single entry of the Concise Oxford Dictionary, could be arranged in alphabetical order in fourteen operations: and even the half-million entries in the thirteen-volume Oxford English Dictionary would need only nineteen operations.

At the cost of using a few more holes and a number of knitting needles simultaneously, a more rapid 'selecting' procedure is possible; with n holes one can code ${}_nC_{n/2}$ items (if n is even) and select any desired card in a single operation using $n/2$ knitting needles simultaneously (for example, 924 items with a twelve-hole code using six needles: twenty-two holes and eleven needles for the Oxford English Dictionary). On the other hand, serial sorting becomes more complicated.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 21

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Reception of Band I and Band III Television Programmes".

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. J. W. Trevan, F.R.S.: "The Pharmacology of Respiratory Regulation".*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Sir Edward Bullard, F.R.S.: "Structure of Ocean Basins" (Joule Memorial Lecture).

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. A. H. Cook, F.R.S.: First of Three Cantor Lectures on "The Science of Brewing". (Further Lectures on November 28 and December 5.)

INSTITUTE OF METAL FINISHING (at the Imperial College of Science and Technology, South Kensington, London, S.W.7), at 6.15 p.m.—Mr. A. Mohan: "The Use of the Electron-Microscope in Electrochemical Research"; Mr. D. I. C. Kapp: "The Application of Technical Studies to Industrial Experience"; Mr. D. M. Gilbey: "The Kinetics of Electrodeposition of Metals".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. F. Atkins: "Some Pharmaceutical Aspects of Modern Cosmetics".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mlle. Ella Maillart: "Along the Malabar Coast".

Tuesday, November 22

ARTHUR STANLEY EDDINGTON MEMORIAL TRUST (at the Examination Schools, Oxford), at 5.15 p.m.—Prof. R. B. Braithwaite: "An Empiricist's View of the Nature of Religious Belief" (Ninth Eddington Memorial Lecture).

UNIVERSITY OF LONDON (at Bedford College, Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. N. Milliott: "Studies on Tropical Echinoderms and Primitive Light Perception".*

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. R. D. Harkness: "Metabolism of Collagen". (Eighth of fifteen Lectures on "The Scientific Basis of Medicine".)*

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. T. Catten: "Ship Lighting".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON GRADUATES AND STUDENTS SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.—Mr. D. E. Mullinger: "Electrical Measurement of Mechanical Vibrations".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. Charles Gardner: "Aviation Journalism".

Tuesday, November 22—Wednesday, November 23

INSTITUTION OF GAS ENGINEERS (at Church House, Westminster, London, S.W.1)—21st Autumn Research Meeting.

Tuesday, November 22—Friday, November 25

INTERNATIONAL CONGRESS ON DOCUMENTATION OF APPLIED CHEMISTRY (at the Institut Français di Royaume-Uni, Queensberry Place, London, S.W.7).

Wednesday, November 23

TEXTILE INSTITUTE (at the Walker Art Gallery, Liverpool)—Conference on "Raw Cotton: Its Properties and Distribution".

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. P. Bishop: "Endocrinological Investigations". (Further Lecture on November 30.)*

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. B. K. Blount: "Research in Industry" (E. Frankland Armstrong Memorial Lecture).

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (in the Conference Room, 4th Floor, Waterloo Bridge House, London, S.E.1), at 5 p.m.—Mr. L. S. Hughes: "English in the Engineering Department".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. C. J. Stairmand: "Modern Industrial Dust Collection".*

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. W. G. Wearmouth: "The Production of Processed Cheese in France and Switzerland"; Mr. A. G. Sansome: "Airborne Contamination of Foodstuffs by Rodent Hairs".

BRITISH ASSOCIATION OF CHEMISTS, LONDON SECTION (at the Wellcome Institute, 183, Euston Road, London, N.W.1), at 7 p.m.—Dr. B. Gorringe: "Applications of Photography in Research and Industry".

Thursday, November 24

INSTITUTE OF REFRIGERATION (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. L. Cowley: "Problems Connected with the Cooling of the Human Body by Means of Mechanical Refrigeration".

Friday, November 25

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "Winds in the Upper Atmosphere (including Drift and Irregularities in the F-Layer)". Chairman: Mr. J. A. Ratcliffe, F.R.S.

ROYAL METEOROLOGICAL SOCIETY (in the Conference Hall, County Hall, London, S.E.1), at 5.30 p.m.—Mr. P. J. Meade: "Fog and Atmospheric Pollution" (Lecture open to sixth-form scholars).

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre, Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. A. R. Flint: "An Analysis of the Behaviour of Riveted Joints in Aluminium Alloy Ships' Plating".

INSTITUTE OF PHYSICS, NON-DESTRUCTIVE TESTING GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Discussion on "Outstanding Problems in Industrial Radiology". Opening Speakers: Mr. R. Halmshaw and Dr. L. Mullins.

UNIVERSITY OF LONDON (at Royal Holloway College, Englefield Green, Surrey), at 8.15 p.m.—Prof. P. M. S. Blackett, F.R.S.: "The Peaceful Uses of Atomic Energy".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. B. F. J. Schonland, F.R.S.: "Lightning and the Long Electric Spark".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with an honours degree and teaching, industrial or research experience) IN CHEMISTRY, at the Rutherford College of Technology, to teach to H.N.C. and A.R.I.C. level—The Director of Education, Northumberland Road, Newcastle-upon-Tyne 1 (November 26).

METALLURGIST (with a recognized metallurgical qualification and with sound experience, preferably in the electricity supply or associated industry) for the Chief Engineer's Department, Central Electricity Authority, London, to guide the branch on all metallurgical problems, co-ordinate metallurgical work in the various Divisions, and represent the Authority at technical meetings—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting AE/691 (November 29).

LECTURER (with an honours degree in zoology, and preferably special knowledge of agricultural entomology, and with research and teaching experience) IN AGRICULTURAL ENTOMOLOGY—The Secretary, School of Agriculture, Downing Street, Cambridge (November 30).

LECTURER (graduate in science or medicine with postgraduate experience in some branch of physiology) IN PHYSIOLOGY—The Assistant Registrar, Medical School, Birmingham 15 (November 30).

SENIOR PHYSICIST (with a university degree in science, preferably with honours, with physics as the major subject, and considerable experience of applied research in physics), to be responsible for the planning and execution of research and related work in physics—The Director, Institute for Industrial Research and Standards, Glasnevin House, Ballymun Road, Dublin (November 30).

ASSISTANT LECTURER, Grade B (with an honours degree in physics and preferably with some teaching and/or industrial experience) IN THE DEPARTMENT OF MATHEMATICS AND PHYSICS—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (December 1).

LECTURER IN GEOGRAPHY—The Secretary of University Court, The University, Glasgow (December 1).

RESEARCH ASSISTANT (with an honours degree in physics) for work in connexion with the study of the upper atmosphere by means of rockets—Prof. D. R. Bates, F.R.S., The Queen's University, Belfast (December 1).

SOIL PHYSICIST (graduate in physics or chemistry) at the Sabi Valley Experiment Station, to investigate the behaviour of soil and water under irrigation and water requirements of crops—The Secretary, Government of the Federation of Rhodesia and Nyasaland, Rhodesia House, 429 Strand, London, W.C.2 (December 3).

ASSISTANT LECTURER IN MATHEMATICS (Pure or Applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (December 5).

LECTURER IN MATHEMATICS—The Secretary of the Appointments Committee of the Faculty of Mathematics, The Arts School, Bene't Street, Cambridge (December 8).

LECTURER (preferably with experience with internal combustion engines or gas turbines) IN MECHANICAL ENGINEERING, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 10).

LECTURER (graduate in science with special qualifications in botany or agricultural botany) IN BOTANY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (December 12).

RESEARCH FELLOW IN ANIMAL ECOLOGY—The Registrar, University of Adelaide, Adelaide, South Australia (December 15).

LECTURER IN HISTORY AND PHILOSOPHY OF SCIENCE in the Department of History and Methods of Science, University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 16).

LECTURER (with good academic qualifications and practical experience, and with particular interest in developing improved methods of teaching engineering drawing and design) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Registrar, The University, Bristol 8 (December 20).

CHAIR OF ORGANIC CHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 14).

BIOCHEMIST to investigate biochemical pathways in the development of cellular damage by ionizing radiations—Dr. L. H. Gray, Director, British Empire Cancer Campaign Research Unit in Radiobiology, Mount Vernon Hospital, Northwood, Middlesex.

ECONOMIC ASSISTANT (with at least a second-class honours degree in economics or similar subject, preferably with a mathematical or statistical background; one or two years postgraduate experience of economics work and an interest in science an advantage), with the United Kingdom Atomic Energy Authority, London, for duties including work on the economic aspects of nuclear power and on the general co-ordination of the nuclear power programme—Room 22, United Kingdom Atomic Energy Authority, 14 Ormond Yard, St. James's, London, S.W.1.

INDUSTRIAL CHEMIST (with an honours degree in chemistry or Member of the Institution of Chemical Engineers, and at least ten years experience as a chemist in industry) IN THE DEPARTMENT OF HEAVY INDUSTRIES, Eastern Region, Nigeria, to advise on the design of a laboratory and afterwards direct its work, to undertake research into local raw materials, organic and inorganic, and their potential utilization either alone or in combination with imported materials—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.461/411/02.

PHYSICIST (with an honours degree in physics) IN THE CLINICAL PHYSICS DEPARTMENT—The Administrative Officer, Christie Hospital and Holt Radium Institute, Manchester 20.

PLANT BREEDER (with at least a second-class honours degree and experience in plant breeding) at the West African Maize Rust Research Unit, Nigeria, to carry out research into maize breeding with special reference to resistance to pests and diseases—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/376/01.

RESEARCH ENGINEER (with an honours degree in engineering and one or two years practical experience) AT THE RESEARCH AND DEVELOPMENT DIVISION of the Cement and Concrete Association, Slough, for work on concrete materials and methods of construction—The Secretary, Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

SENIOR GENETICIST (with at least a second-class honours degree in botany or other natural science, with some years experience of plant breeding and genetics and preferably acquainted with tropical perennial crops, particularly oil-palm or coconut-palm and maize breeding; cytological experience especially valuable) as Head of the Plant Breeding Division, West African Institute for Oil Palm Research, Nigeria, to plan and execute the research programme of the division, which is directed towards improving the oil-palm by selection and breeding, and includes investigation of the genetics and cytology of the crop—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/199/08.

SENIOR SCIENTIFIC or SCIENTIFIC OFFICERS (with a first- or second-class honours degree in mathematics, physics or engineering, or equivalent qualification, preferably with experience in aeronautical research or development work in aircraft industry) at the London Headquarters, Ministry of Supply, for co-ordination of aerodynamic research at Research Establishments, and of research projects at aircraft firms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.396/5A.

SOIL SCIENTIST (Analyst) (with at least a second-class honours degree in chemistry with one or two years postgraduate experience) in the Western Region, Nigeria, to carry out soil analyses and nutritional studies of cocoa and annual crops as a member of a team engaged in the systematic classification, mapping and characterization of soils and studies of their fertility—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/410/015.

THEORETICAL NUCLEAR PHYSICIST (with a first-class honours degree in mathematics or physics and several years postgraduate research experience in nuclear physics), to carry out fundamental research in nuclear physics, particularly on the theory of nuclear structure, and to advise on the best values of nuclear constants to use in numerical calculations and on the design and interpretation of nuclear physics experiments—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 799/2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Registrar General's Statistical Review of England and Wales for the two years 1950–1951—Supplement on Hospital In-Patient Statistics. Pp. iv+151. (London: H.M. Stationery Office, 1955.) 7s. 6d. net. [228

Aero Research Technical Notes. Bulletin No. 150: Modern Production Techniques with "Aerolite" K, KL and R. Pp. 5. (Duxford: Aero Research Limited, 1955.) [228

The Dogs' Champion. Vol. 1, No. 1 (July, 1955). Pp. 2. (London: Canine League Defence Fund, 1955.) Free to Supporters. [228

Anti-Locust Bulletin 20: The Vegetation of the Outbreak Areas of the Red Locust (*Nomadacris septemfasciata* Serv.) in Tanganyika and Northern Rhodesia. By D. F. Vesey-Fitzgerald. Pp. ii+31+8 plates. (London: Anti-Locust Research Centre, c/o British Museum (Natural History), 1955.) 3s. 6d. [228

Automation Age. Vol. 1, No. 1 (August, 1955). Pp. 6. (London: United Trade Press, Ltd., 1955.) Annual subscription 10s.; Single issues 1s. [248

Regulations for the Electrical Equipment of Buildings. Thirteenth edition. Pp. viii+182. (London: Institution of Electrical Engineers, 1955.) Paper 6s.; Cloth 8s. 6d. [298

Amateur Entomologists' Society. Leaflet No. 27: A Study of the Insects Living on the Wayfaring Tree. By K. C. Side. Pp. 20. (London: Amateur Entomologists' Society, 1955.) 1s. 6d. [298

The Atom: Servant of Man. Pp. 13. (London: United States Information Service, 1955.) [298

Modern Apparatus for Sterilization: an Address given to an Evening Meeting of the Pharmaceutical Society of Great Britain in Edinburgh on February 16, 1955. By J. H. Bowie. (Reprinted from *The Pharmaceutical Journal*, June 11 and 18, 1955.) Pp. 24. (London: The Pharmaceutical Press, 1955.) 2s. 6d. [298

Other Countries

Museum of Comparative Zoology at Harvard College. Breviora, No. 45 (June 13, 1955): ***Palaeolarichs Oligocenica*, New Genus and Species, an Oligocene Salamander from Oregon.** By Richard van Frank. Pp. 12+3 plates. No. 46 (June 24, 1955): **Cave-Fossil Vertebrates from Camaguey, Cuba.** By Karl F. Koopman and Rodolfo Ruibal. Pp. 8. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1955.) [228

Publications of the Kapteyn Astronomical Laboratory, Groningen. No. 56: Proper Motions of Stars in the Selected Areas at the Equator derived from Plates taken at the Alger Observatory. By P. J. Van Rhijn and L. Plaut. Pp. ii+100. (Groningen: Kapteyn Astronomical Laboratory, 1955.) [228

Universidad Nacional de Tucuman: Facultad de Ciencias Exactas y Tecnologia. Revista. Serie A: Matematica y Fisica Teorica. Vol. 10, Nos. 1 y 2: **Resultados Generales Referentes a la Descripcion de un Foton en un Medio Material, Por A. Battig.** Pp. 111–186. (Tucuman: Universidad Nacional de Tucuman, 1954.) [228

East African Meteorological Department, Memoirs. Vol. 3, No. 3: **Report on Experiments on Artificial Control of Rainfall at Amboseli, Kenya and Dodoma, Tanganyika, 1953–54.** By D. A. Davies, Dr. H. W. Sansom and G. Singh Rana. Pp. 21. (Nairobi: East African Meteorological Department, 1955.) Sh. 4. [228

Report of the Fourth Meeting of the FAO Working Party on Mediterranean Pasture and Fodder Development, held in Lisbon, Portugal, 6–16 May, 1955. (Meeting Report No. 1955/12.) Pp. 49. (Rome: Food and Agriculture Organization of the United Nations, 1955.) [228

Provincia de Mocambique. Servicos de Industria e Geologia. Série de Geologia e Minas—Memorias e Communicacoes. Boletim No. 14: Estudos Geoquimicos das Aguas Superficiais e Subterraneas das Rochas Sedimentares do Sul do Save. Por Dr. Vero Louis Bosazza. Pp. 44+3 plates. (Lourenco Marques: Artes Graficas, Lda., 1955.) [228

Education and Race Relations in South Africa. By Dr. F. B. Davie. (Eleventh Hoernlé Memorial Lecture.) Pp. iii+31. (Johannesburg: South African Institute of Race Relations, 1955.) [228

Suomen Geodeettisen Laitoksen Julkaisuja. Veröffentlichungen des Finnischen Geodätischen Institutes. Nr. 46: Professori Weikko A. Heiskaselle hänen 60-vuotispäivänä omistettu juhlajulkaiso. (Publication dedicated to Weikko A. Heiskanen on the occasion of his 60th anniversary.) Pp. 214. No. 47: **Bemerkungen zur Methode der Basismessung mit Hilfe der Lichtinterferenz.** Von Y. Väisälä. Pp. 12. (Helsinki: Suomen Geodeettisen Laitoksen Julkaisuja, 1955.) [228

Bulletin der Schweizerischen Gesellschaft für Anthropologie und Ethnologie 1954/55. (31. Jahrgand.) Schriftleitung: Dr. Otto Schlaginhaufen. Pp. 111+5 plates. (Zürich: Société Suisse d'Anthropologie, 1955.) 7.50 Swiss francs. [228

Uganda Protectorate. Annual Report of the Geological Survey Department for the year ended 31st December, 1954. Pp. ii+38. (Entebbe: Geological Survey, 1955.) Shs. 1/75. [228

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture (I.R.S.I.A.). Comptes Rendus de Recherches. No. 15: Travaux du Comité National pour l'Étude de la Culture Fruitière. Pp. 111. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1955.) 125 francs. [228

British Honduras. Annual Report of the Forest Department for the year 1954. Pp. 28. (Belize: Conservator of Forests, Forest Department, 1955.) [228

Bookers Sugar. Pp. 126. (Georgetown, British Guiana: Bookers Sugar Estates, Ltd., 1954.) [228

Forschungsberichte des Wirtschafts- und Verkehrsministeriums Nordrhein-Westfalen. Herausgegeben von Prof. Leo Brandt. Nr. 157: Untersuchungen über die Stossvorgänge zwischen neutralen Atomen und Molekülen. Von Dr. W. Jawtusch und Prof. R. Jaeckel. Pp. 35. (Köln und Opladen: Westdeutscher Verlag, 1955.) 10.50 D. marks. [228

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the year ended 31st December 1954. Pp. 27. (Zomba: Government Printer, 1955.) 2s. 6d. [228

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